JOURNAL OF THE

SMPTE

89th SMPTE Convention • May 7–12 • King Edward Sheraton, Toronto

volume 70 • number 1

JANUARY 1961

JOURNAL of the
SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

PUBLICATION OFFICE TWENTIETH AND NORTHAMPTON STREETS EASTON, PA.

. . .

Subscriptions to nonmembers, $12.50 a year (outside continental United States, add $1.00 for postage); subscribers residing in countries which participate in UNESCO may use UNESCO coupons in submitting subscription payments in the event other means of remitting are not available; single copies, $2.00 for one-part issues, $2.50 for special two-part issues. A 10% discount is allowed to individual members and accredited agencies on orders for subscriptions and single copies. A list of priced and gratis publications is available. Order from the Society's Headquarters Office, 55 West 42d St., New York 36.

. . .

THE SOCIETY is the growth of over forty years of achievement and leadership. Its members are engineers and technicians skilled in every branch of motion-picture film production and use, in television, and in the many related arts and sciences. Through the Society they are able to contribute effectively to the technical advance of their industry. The Society was founded in 1916 as the Society of Motion Picture Engineers and was renamed in 1950.

Membership in Sustaining, Active, Associate or Student grades is open to any interested person according to his qualifications. Information about membership, technical activities and standards and test films for the industry is available from Society Headquarters. Members residing in countries which participate in UNESCO may use UNESCO coupons in submitting membership payment in the event other means of remitting are not available.

SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

Headquarters Office: 55 West 42d St., New York 36, N.Y. Cables: Somopict Telephone: LOngacre 5-0172

Executive Secretary: CHARLES S. STODTER

Published monthly by the Society of Motion Picture and Television Engineers. Publication office 20th and Northampton Sts., Easton, Pa. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.

Printed by Mack Printing Company, Easton, Pa.

Journal of the Society of Motion Picture and Television Engineers

VOLUME 70 · NUMBER 1 · JANUARY 1961

Some Philosophical Aspects of High-Speed Photographic Instrumentation

By MORTON SULTANOFF

The sources of uncertainty in the interpretation of photographic records obtained by many of the techniques employed in high-speed photographic instrumentation are examined. The need for a good physical understanding of the events being studied is shown to be an essential requirement in the analysis of the photographically recorded luminous output to that event.

Difficulties which arise in the analysis of rotating-mirror streak-camera records are described and the simultaneous use of associated equipment to overcome these difficulties is recommended. The need for "mental conditioning" to avoid the pitfalls of misinterpreted high-speed photographic recordings is demonstrated. The nature of the cameras, the recorded light and the physical characteristics of the events being studied must be carefully analyzed to avoid typical misinterpretations, several of which are illustrated in this paper.

The average photographic experience in the instrumentation field deals with pictures obtained with reflected-light exposures and to a lesser degree with back-lighted subjects. The interpretation of these photographic records is usually straightforward and is based on a "what you see is what took place" attitude. When the field of photoinstrumentation is extended to the study of high-speed phenomena, the events often have associated with them a degree of self-luminosity which influences, and often controls, the photographic exposure. These records can no longer be directly interpreted but frequently involve the need for extended experiments. The lack of a single reference or a concise summary of the large variety of ambiguous results which have been obtained in new studies has led to misinterpretations, many of which have appeared in the literature as scientific facts.

Even when the source of light and its association with the physical event being investigated are accurately appraised, the effect of the short exposure times, as compared to that obtained in the average photograph, which integrates over comparatively long times, must be assessed. This is especially true in records obtained with the "smear" or "streak" camera, which exposes fixed space through a slit as a function of dissected time often resolved to less than 10^{-8} sec. Both the fine time resolution and the fixed narrow-slit view of unusual events have added to the confusion of interpretation, and many events reported in papers in the past are described in terms of unusual physical parameters which do not actually exist. The attempts to describe, in terms of sound physical principles, those results which are "instrumentation manifestations" and which can be changed almost at random by changing the aperture, time resolution or position of view frequently appear in scientific papers. It is intended in the discussion which follows to bring to light some of the specific unusual characteristics of high-speed photographic instrumentation of extremely rapid events and to present an overall general analysis of the type of observations which most frequently result in misinterpretation.

Presented on October 21, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D. C., by Morton Sultanoff, Ballistic Research Laboratories, Aberdeen Proving Ground, Md.

Self-Luminosity of Rapid Events

Chemiluminescence

Many high-speed events are either chemically supported by a reaction which supplies the energy required for their propagation, or they were propagated or supported by a past history of chemical events completed at the time of observation. Explosive and propellant studies are included in the former category, whereas missile flights, following or during a propellant boost, are typical of the latter type. The intensity of the luminosity in a chemical reaction is a function of the materials involved and of the rate, pressure and temperature of the reaction. Spectrally the output of such an event consists of radiation of the characteristic frequencies of the elements involved in the reaction and does not produce the continuous spectrum of equilibrium black- or gray-body sources. This light, as recorded, is often interpreted as the reaction front, but because of the variation in luminosity through the reaction zone, the position of the "front" and "end" of such a zone can be observed to change with aperture and exposure time in photographic recording. Direct interpretation of such reactions should be supported by auxiliary instrumentation as well as with varied exposures in the photographic recordings.

Excitation Radiation

When certain materials, especially gases, are subjected to high energy pulses such as pressure or electrical dis-

charge, their internal energy level is raised, and upon the removal or passage of the excitation pulse, the absorbed energy is reradiated.

The portion of that energy which is observed in the visible portion of the electromagnetic spectrum is a function of the excited material. High-gamma (gamma is the ratio of specific heats) gases radiate intensely whereas visible radiation in low-gamma gases is not detectable with short-exposure-time photographic instruments. The spectral quality and intensity of this radiation is related directly to the excitation pulse and to the material being pulsed. The instantaneous position and intensity of such pulses cannot be directly inferred from photographic records alone, but requires auxiliary supporting evidence.

Incandescent Radiation

The most widely recognized and used illumination for photographic purposes is generated by the heating of solid or gaseous substances to high temperatures, causing them to radiate a continuum characterized by "color temperature," or spectral distribution, which follows black- or gray-body emissivity curves. Usually the intensity of the radiation from constant incandescent sources is too low for very short recording times. However, in rapid events which necessitate the use of high-speed photographic instrumentation, projectile heating or atmospheric ablation of hypervelocity particles produces an incandescent level which can be easily recorded at times shorter than a microsecond.

Exposure Effects: The Effects of Time

Exposure Duration

Two time components are involved in all photographic exposures. The first, which is perhaps the more important in the analysis of the event being studied, is the actual duration of the exposure. Drastic changes may be experienced by changes in exposure duration, especially in the study of rapid events which have moving luminous zones of various intensities and thicknesses. The film exposed to such events integrates over time and space; and this integration, which results in exposure variations, can present misleading information. Since a specific case history of this type of observation based on experiences of the author will not be presented, it is interesting to note that W. C. Davis and A. W. Cambell[1] reported an investigation of the work published by M. A. Cook and W. S. McEwan[2] and showed that an unusual physical phenomenon reported by the latter authors was only a manifestation of exposure effects brought about by time and space integration which led to misconclusions.

Relative Time to Exposure

The relative time to exposure, which is that instant in the life of the event at which the exposure is made, is the second "time" of significance in the interpretation of photographic results. If a correlation of this "time" to the total event history is not known with absolute confidence within the normal experimental error, misinterpretation of the position of event phases based on an absolute or relative scale can lead to peculiar physical explanations. This uncertainty could arise from uncalibrated auxiliary light sources with multiple peaks or long tails which give rise to unusual integrated effects; oscillations in shuttering devices, especially in electrooptic, magnetooptic or electronoptic devices; or failure of the synchronization system in a device where relative time control for the shuttering of the device and timing of the event are essential.

Lack of Recorded Information

With all the conditions of light, time and synchronization fully analyzed so that the identity of the physical characteristics and the time history of these characteristics have been resolved, one is faced with the fact that there is no single "perfect" recording device. All cameras which operate in the microsecond or submicrosecond time regime are, at best, designed with a minimum of compromises. The essential qualities desired are usually high optical resolution, short time resolution, good space resolution, a long sequence of photographs with very short intervals or dwell time, large effective aperture, lack of synchronization requirement and large frame size. High-speed cameras are generally designed to satisfy one or, at most, two of these parameters, allowing the

Fig. 1. Typical streak-camera record of the jet from a shaped charge.

others to fall where they may at the expense of the one or two which have been selected as paramount for a specific application.

Streak- or smear-camera records are capable of analyses which produce the best quantitative data, but completely lack qualitative information. Single-exposure Kerr cells or similar shutters produce exceptional qualitative records, but fail to produce time continuity in rapid events; therefore, quantitative Kerr-cell data must be "inferred." Many of the better multiframe cameras compromise both the quantitative and qualitative parameters to obtain a time continuity involving both these factors.

With the choice of a camera, often dictated by primary need and cost, the problem of inadequate recorded information can lead to misinterpretation of a rapid event. The most accurate and perhaps the most widely used instrument for quantitative studies is the rotating-mirror streak- or smear-camera. However, the records obtained with this camera account for most of the incorrect analyses of physical events, specific examples of which are presented in the following discussions.

Specific Case Histories

Shaped-Charge Performance: Ambiguities Eliminated by Analysis of Source of Recorded Light

A direct recording by a streak camera of the formation and propagation of the solid metal jet from a military "shaped charge" is shown in Fig. 1. The earliest observation of light is produced by an event with an initial velocity of approximately 12,000 m/sec, which is decelerating rapidly. The trace then appears to continue at a uniform velocity of about 7500 m/sec for a considerable distance. This record alone would lead one to believe that the metal jet had an initial tip velocity which decayed to the lower steady-state velocity, and thus had performance characteristics which defy logical physical descriptions. However, it is shown clearly in Fig. 2 that the early high-velocity phenomenon is stopped and reflected by a thin target placed close to the charge. This stopping power of such a target shows clearly that the first high-velocity phenomenon cannot be the solid metal jet. If one studies earlier flash radiographic records and follows the process of shaped-charge cone collapse, it becomes evident that the existence of this shock should be expected when the air in the cone is driven by the collapsing walls, colliding to form a Mach bridge, which emerges as observed.

The solid metal jet in free flight is evident when the obscuring nature of this preliminary shock is eliminated by a baffle, or when it is outrun by the jet. The observation of the jet in flight is now questionable since the reason for the observed luminosity is not evident. Figure 3 shows the arrangement of cells of air, propane and argon in the path of the jet. The streak-camera record presented in this figure shows the obvious change in luminosity which indicates that it is the aerodynamic shock at the head of the jet which is recorded photographically. Since this shock is directly associated in position with the tip of the jet, velocity obtained from measurements of the recorded luminous intensity directly represent the tip velocity of the jet. At the measured velocities, the tip of the jet must become incandescent by meteoric heating, and ablation takes place. The light from this reaction is secondary in intensity, and exposures with durations of 10^{-8} sec used in these studies do not record this light.

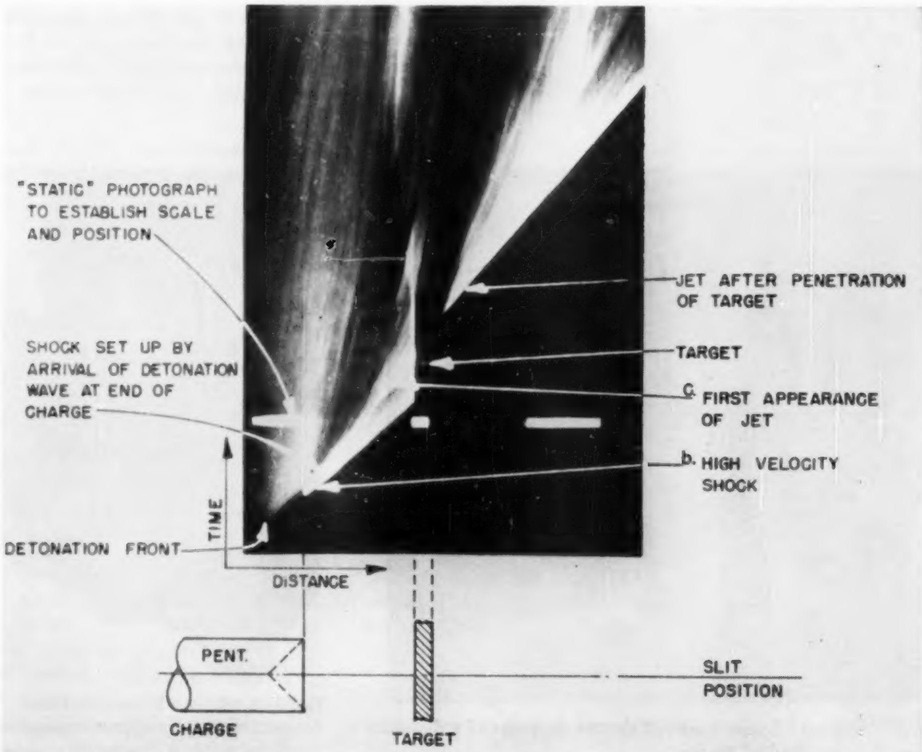


Fig. 2. Streak-camera record of the jet from a shaped charge passing through a thin target to baffle out air shock.

Fig. 3. Streak-camera record of the transit of shaped-charge jet through air, propane and argon to observe the effect on luminosity.

The Dark Space in High-Order Detonation and Its Association with Self-Luminosity

Many studies of explosive events are conducted using high-speed photographic techniques.[3,4] The nature and physical identity of the phases of detonation are dependent on an analysis of the sources of luminous radiation in these studies. An earlier report describes the "dark space," or light discontinuity, observed in such studies.[5] A typical Kerr-cell record of a detonation, which clearly shows this dark space, is presented in Fig. 4. The luminosity ahead of this space and its association with the detonation process appears to be a physically discontinuous one. However, by testing charges in propane to quench the self-luminous shock and with backlighting to locate the boundaries of the shock and product envelope, as shown in Fig. 5, it becomes evident that the location of the detonation front ties into the expanding envelope of products and shock in a physically continuous front. Figure 6 shows a typical streak-camera velocity record taken through a density step-wedge to determine if the dark-zone width is a constant physical quantity or if it is a manifestation of exposure. This observation of the existence of a dark zone of constant width shows that its physical existence is real.

Physically Incompatible Shock, Detected Through Insufficient Recorded Information

Figure 7 (a_1) shows the typical shock from a spherical explosive charge observed at a distance from the charge at which it is no longer self-luminous. Backlighting employed in this type of recording adequately resolves the shock so that velocity measurements can be obtained. When spherical charges are centrally initiated, the resulting envelope of shock is sufficiently symmetrical to use observations along one radius and infer expansion rates in all directions. Figure 7 (b_1), however, is typical of records obtained which show "obvious" rates of acceleration and deceleration. A consistent physical

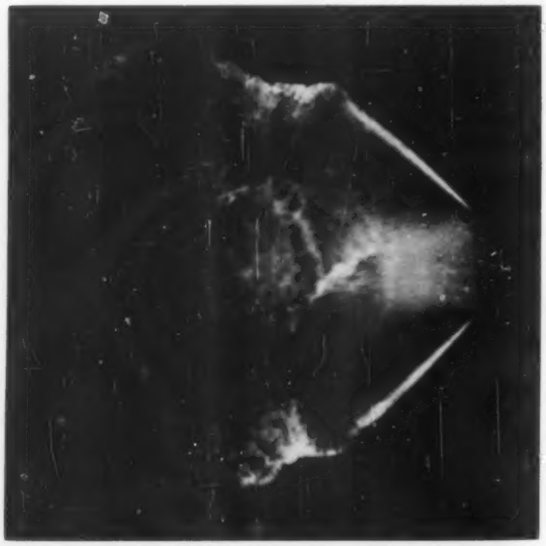


Fig. 4. Typical 0.1 μsec Kerr-cell shutter exposure of a detonation showing the dark space.

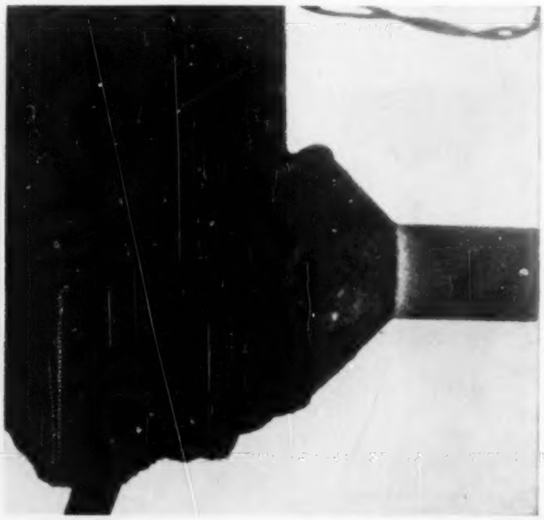


Fig. 5. A 0.1-μsec Kerr-cell shutter exposure of a backlighted detonation in a propane atmosphere to show continuity of reaction-front and detonation products.

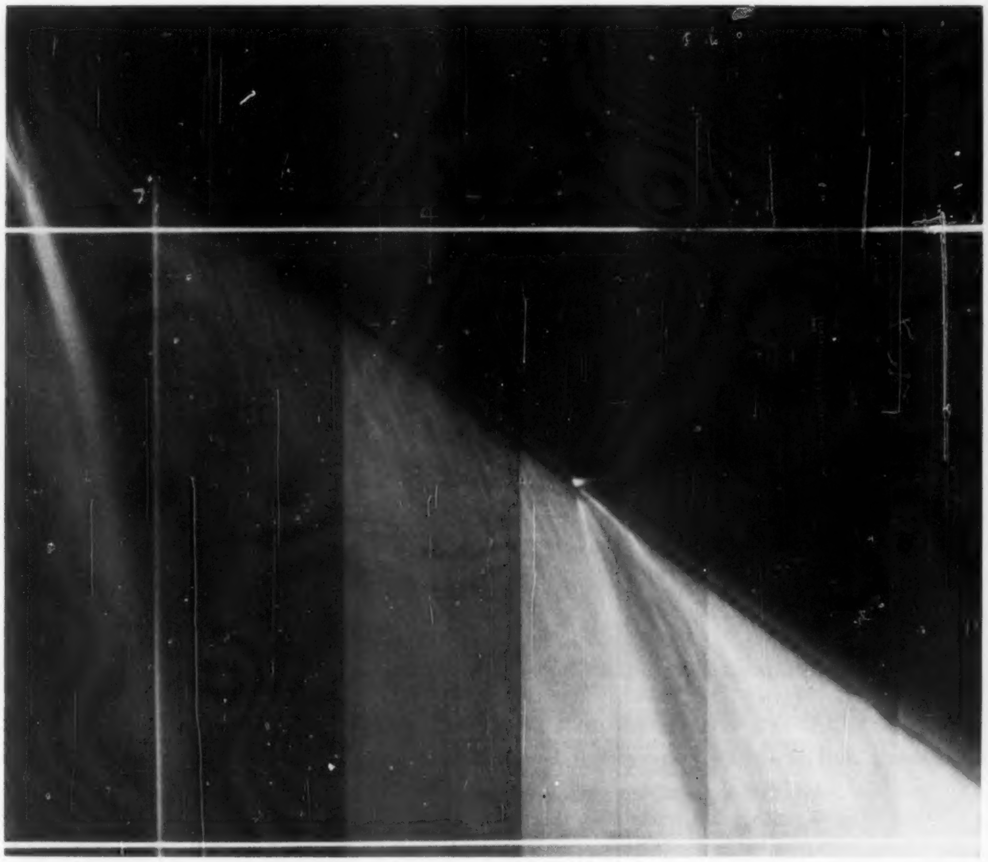


Fig. 6. Typical streak-camera velocity record of a detonation taken through a density step-wedge to show effect of exposure on dark-space width.

explanation was nonexistent for this type of observation, and at first the inclination was to explain them as the result of shock reflections causing successive "implosion" and "explosion" shocks. Before proposing such a physical picture to explain these observations, it was felt that the lack of qualitative data in streak-camera records might hide some acceptable explanation for this apparently erratic behavior.

A $\frac{1}{10}$-μsec Kerr-cell shutter was arranged as shown in Fig. 8, using a single first lens and a half-silvered mirror so that simultaneous rotating-mirror-camera streak records and single-exposure Kerr-cell records were obtained. Figure 7 is a composite of the simultaneous records printed to the same distance scale, and the event time at which the Kerr-cell exposure was obtained is shown by the constant-time line at the proper position on the streak-camera records a_1 and b_1. Local eruptions, causing local perturbations on the main shock envelope, are obvious in Fig. 7 (b_1 and b_2).

With stereo-pair photographs it became apparent that flakes of unreacted explosive from the surface of the spherical charges followed behind the main shock. These particles entered an environment which caused detonation; and a high-pressure (high-velocity) low-total-energy pulse disturbed the main shock envelope, but rapidly decayed. The main envelope of shock then overtook it. When these local eruptions occurred in the line of vision of the streak-camera slit, the peculiar records, as shown in Fig. 7, were obtained.

Conclusions

A mental conditioning which emphasizes a degree of skepticism in the first interpretation of high-speed photographic records, especially when such interpretations must involve unusual or incompatible physical concepts, is an essential requirement in order to avoid the common misinterpretations described. In many photographic instrumentation studies a first "what you see is what took place" attitude is not justified. The radiation recorded in the exposures must be analyzed. The association of this radiation to the phase of the event must then be made, and the characteristics of the recording equipment that might produce results which appear real, but which are actually manifestations of instrumentation, must be understood. Sound data with a firm physical basis can be obtained only through such analysis; and one should be wary of new or unusual physical explanations required to justify results obtained by high-speed photographic instrumentation.

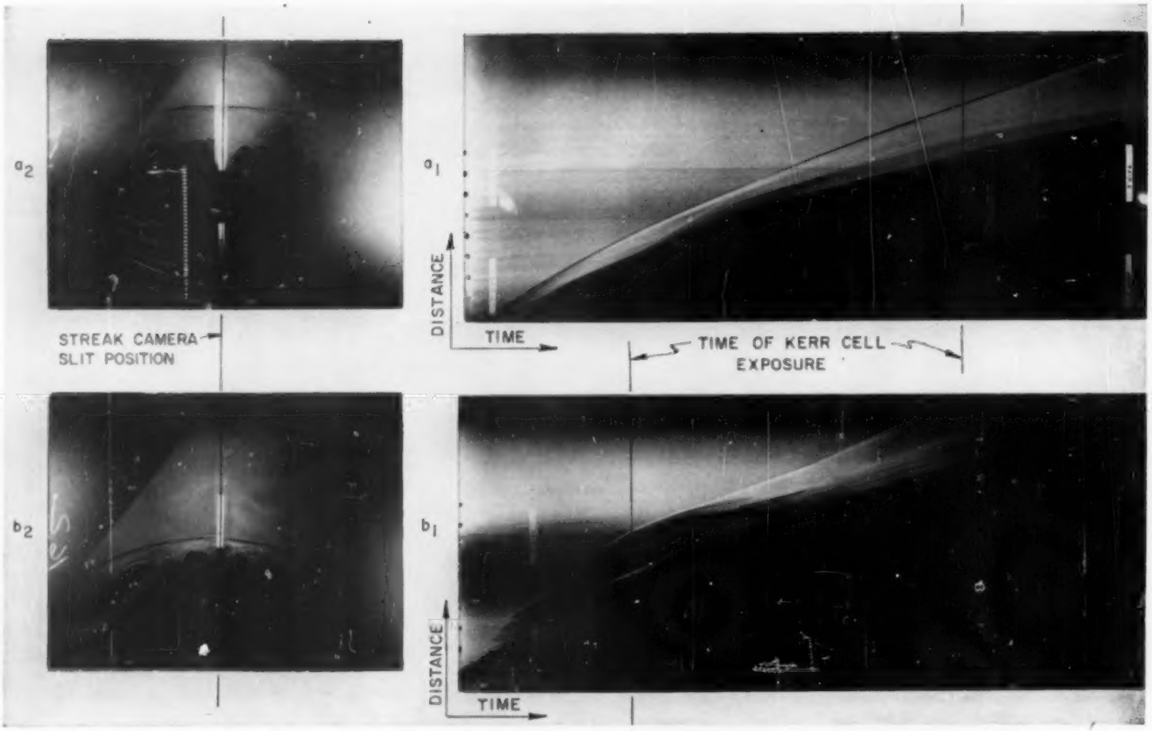


Fig. 7. Results obtained with Fig. 8 arrangement showing physical conditions leading to unusual records of spherical shock expansion.

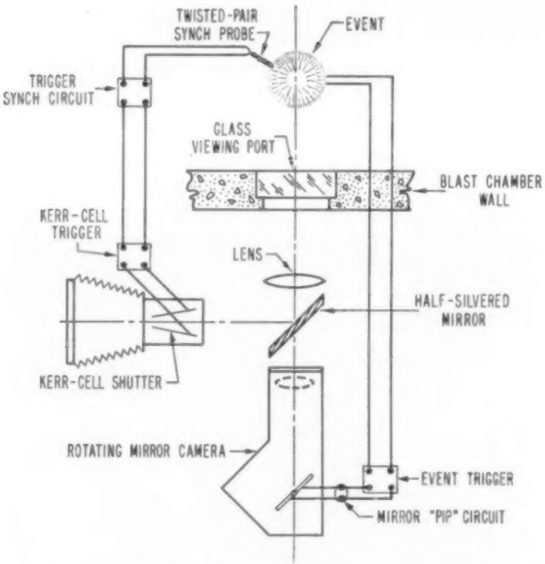


Fig. 8. Arrangement for simultaneous Kerr-cell shutter and streak-camera recording.

References

1. W. C. Davis and A. W. Campbell, *J. Appl. Phys., 31:* 1225–1227, July 1960.
2. M. A. Cook and W. S. McEwan, *J. Appl. Phys., 29:* 1612, 1958.
3. Morton Sultanoff, "Photographic instrumentation in the study of explosive reactions," *Jour. SMPTE, 60:* 145–165, Feb. 1953; also *High-Speed Photography*, SMPTE Reprint Vol. 5, 178–198, 1954.
4. Morton Sultanoff, "Recent developments in photographic instrumentations for the study of explosive reactions," *Proc. 2nd International Congress on High-Speed Photography*, 230–237, Dunod, 92 rue Bonaparte, Paris 6, 1956.
5. Morton Sultanoff, *J. Phot. Sci., 5:* 27–31, 1957.

Ed Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

Holdover in Xenon Flashlamps

By HAROLD E. EDGERTON
and DAVID A. CAHLANDER

When a flashlamp is required to flash at high rates, the charging circuit is required to supply more current. Eventually, a condition arises where the flashlamp does not deionize but goes into a continuous arc that is called "holdover." Conditions for the limiting frequency in terms of circuit and lamp volt-ampere characteristics are given. Experimental data on several flashlamps are presented. Circuits which force a flashlamp to operate at high frequency even if it does not deionize are discussed.

Xenon-filled electronic flashlamps have found many uses in high-speed motion-picture photography and multiple-exposure photography, as well as the more common single-flash photography. The maximum flashing rate for a flashlamp is often limited by arc "holdover." A flashlamp is said to be in a state of "holdover" when it stays in a continuously conducting condition instead of deionizing, which is the desired performance. Large continuous currents can flow in the flashlamp when it is in the holdover condition. This may cause the electrodes and the tube to overheat, depending upon the properties of the energy source and the charging circuit.

The ability of an electrical-discharge flashlamp to give repetitive flashes of light from a condenser discharge in rapid succession depends upon the characteristics of the ionized gas in the lamp during deionization and the characteristics of the charging circuit. The evaluation of the upper frequency limit of a flashlamp and circuit is the object of this paper.

Normal operation of a simple type of flash circuit is shown in Figs. 1 and 2. At the start of the flash the condenser voltage is at the rated value depending upon the particular conditions. This is shown on the accompanying time-voltage diagram, Fig. 2. During discharge, the tube current, i_1, rises to a high value within a short time and then decreases to zero as the condenser voltage decreases to a low value, and the charging current, i_2, from the source begins to flow into the condenser. The maximum discharge current in the lamp is usually much larger than the maximum charging current. The condenser voltage rises slowly to its initial value during the charging cycle while the charging current decreases slowly to zero. This is shown on the time diagram.

Should the tube exhibit holdover difficulties, the condenser voltage will remain at a low value and the charging current, i_2, will flow continuously through the flashlamp. After the initial flash the tube will emit a feeble glow which is very dim in comparison to the flash. No more flashes can be obtained from the lamp until the glow has been extinguished by interrupting the circuit and the storage condenser is recharged. The lower three curves of Fig. 2 show the electrical conditions during holdover.

Whether or not a given tube will holdover under specified conditions is an important question. The external factors which influence holdover for a specific flashlamp are: (1) the voltage to which the condenser is charged; (2) the energy per flash; and (3) the rate at which the lamp is to be flashed.

Presented on October 17, 1960, at the Fifth International Congress on High-Speed Photography by Harold E. Edgerton (who read the paper) and David A. Cahlander, Dept. of Electrical Engineering, Massachusetts Institute Technology, Cambridge 39, Mass.

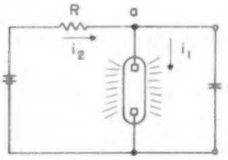


Fig. 1. Simple type of flash circuit. Discharge circuit, i_1, charge circuit, i_2.

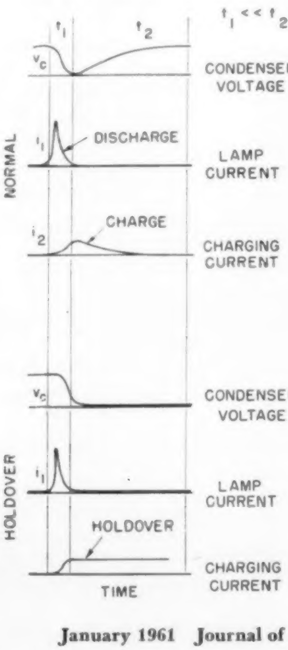


Fig. 2. Normal operation of flashlamp is shown in the upper three curves. The holdover condition is shown in the lower three curves.

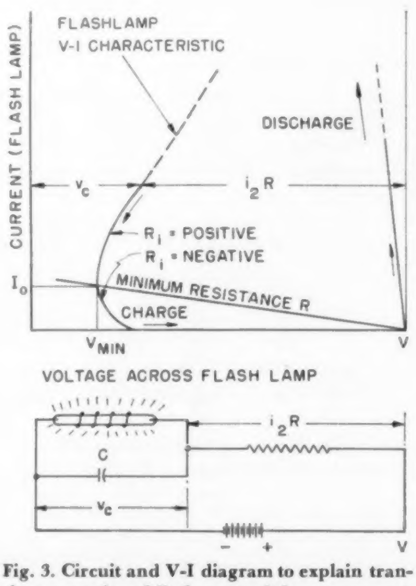


Fig. 3. Circuit and V-I diagram to explain transient excursion of discharge and charge currents.

Deionization Conditions

The electrical conditions at the terminals of the flashlamp will now be examined at the time of discharge, for the simple resistance charging system from a battery or power supply (Fig. 1). A high-resistance flashlamp in which the discharge current is not oscillatory will discharge the capacitor to about 50 or 100 v. At the end of the discharge there is an important three-way division of the current at the point "*a*."

As long as the current into the lamp is greater than some limiting value, the light will not extinguish. This current, I_0, is the current at the minimum voltage point, $V_{\min}$, of the characteristic curve of the flash tube. At low currents the incremental resistance, $R_i = \Delta V/\Delta I$, of the tube goes through zero and then negative (Fig. 3). If the power supply load line intersects the *V-I* curve above the minimum voltage point, a stable condition can occur where the power supply continues to supply current to the flashtube, i.e., holdover. If the load line intersects the V-I curve below the minimum voltage point, the unstable condition of a negative resistance in parallel with a capacitor occurs and the lamp will deionize. (Overheated electrodes will cause a change in the *V-I* characteristics.)

Therefore, holdover will not occur if the residual flashlamp current at the end of the discharge is less than I_0, the lamp current at the minimum voltage point on the lamp transient *V-I* characteristic. Referring to Fig. 1, the maximum charging current must be less than I_0, to insure deionization.

The *V-I* characteristic of the lamp is only slightly different for steady state and transient conditions due to heating and residual ionization left by the large discharge conditions. An inductance in the lamp discharge circuit will enable the experimental procurement of the entire *V-I* curve, since the current through the lamp is then forced to go to small values in the negative resistance region of the characteristic curve.

Figure 4 shows both steady state and transient curves for the GE FT-506 Flashlamp. The minimum voltage point for this lamp is about 80 v, and occurs at a current of 0.6 amp.

Minimum Resistance

The minimum charging resistance can now be calculated for the FT-506 flashlamp. At the deionization point the voltage across the resistor is $(V_0 - V_{\min})$ and the maximum allowable charging current is $I_0 = 0.6$ amp. Thus,

$$R = \frac{V_0 - V_{\min}}{I_0} = \frac{900 - 80}{0.6} = 1400 \text{ ohms for a 900-v power supply}$$

where R = minimum charging resistance
V_0 = supply voltage
$V_{\min}$ = minimum voltage on the *V-I* curve of the flashlamp
I_0 = current at the minimum voltage point

That is, the FT-506 flashlamp will tend to exhibit holdover if the charging resistance is less than 1400 ohms.

Maximum Flashing Frequency and Minimum Time Between Flashes

The charging time constant for the flash capacitor charging circuit is *RC* sec, where *C* is the discharge capacitance in farads and *R* is the charging resistance in ohms. If we consider three times the time constant to be

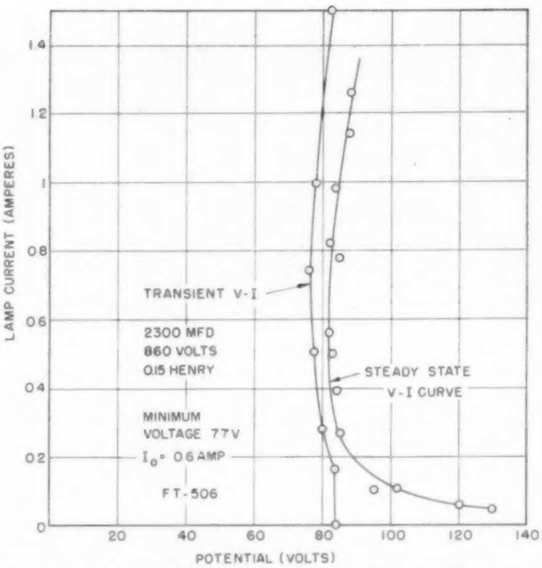


Fig. 4. Volt-ampere characteristics of the GE FT-506 Flashlamp.

ample for charging the capacitor (about 90% of full energy), then the minimum time between flashes, T, is given by

$$T = 3\,RC \text{ (sec)}$$

Substituting for R

$$T = 3\left(\frac{V_0 - V_{\min}}{I_0}\right) C \ .$$

or approximately

$$T = \frac{3\,CV_0}{I_0} \text{ if } V_{\min} \ll V_0$$

In terms of stored energy $W = \left(\frac{CV^2}{2}\right)$, the minimum time between flashes is:

$$T = \frac{6W}{I_0\,V_0} \text{ (sec)}$$

The maximum flashing frequency is

$$f = \frac{1}{T} = \frac{I_0\,V_0}{6W} \text{ (flashes/sec)}$$

Example: Consider the FT-506 flashlamp with 1000 w-sec stored energy, on a 900-v circuit.

$I_0 = 0.6$ amp, $V_0 = 900$ v, and $W = 1000$ w-sec

$$T = \frac{(6)\,(1{,}000)}{(0.6)\,(900)}$$

or $T = 11$ sec between flashes (minimum)

$$f = \frac{1}{T} = 0.09 \text{ flashes/sec (maximum)}$$

With reduced energy per flash the charging time becomes shorter. Consider a 10 w-sec condition. Then,

$I_0 = 0.6$ amp, $V_0 = 900$ v, and $W = 10$ w-sec

$$f = \frac{(0.6)\,(900)}{(6)\;(10)}$$

i.e., $f = 9$ flashes/sec (maximum)

This flashing frequency is 100 times the 1,000 w-sec value, since the maximum flashing rate is inversely proportional to the energy.

Table I, shows the holdover current, I_0, for several flashlamps of common interest.

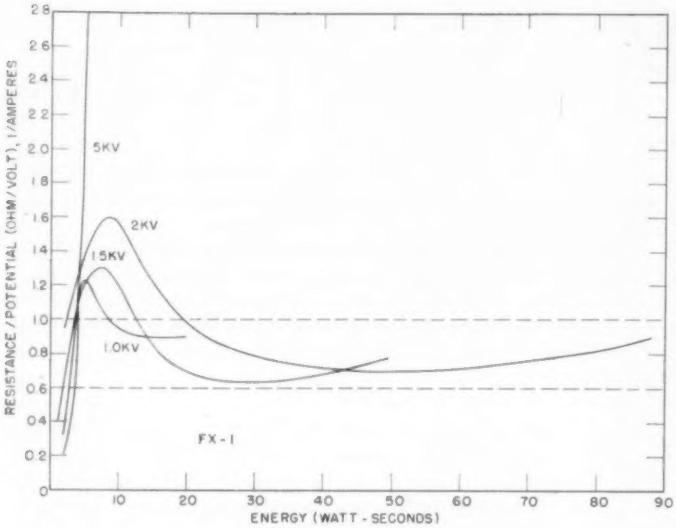


Fig. 5. Experimental data of FX-1 Flashlamp showing limiting current as a function of watt-second loading (Robert Flieder).

Fig. 6. Theoretical (solid curve) and experimental data (circles) showing the maximum flashing frequency as a function of the watt-second loading at a particular voltage.

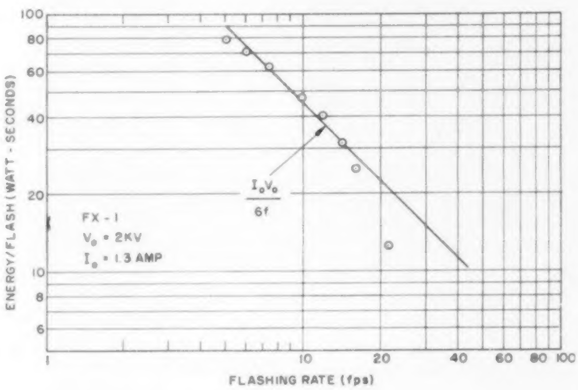


Table I. Holdover Currents for Some Flashlamps.

Flashlamp Type	Arc length, cm	Tube ID, cm	V_{min}, v	I_0, amp
FT-506	15	0.5	80	0.6
FT-118	7	0.4	45	1.5
FT-503	35	0.7	200	1
FX-1	15	0.4	80	1.1
FX-29	10	0.9	75	2

Methods of Decreasing I_0

For flash units that require a shorter charging time than that which has been derived above, one has to devise some special methods of reducing the charging current until deionization occurs. Holdover can be prevented or avoided in several ways. Some methods will now be discussed in detail.

(*1*) *Use of a Relay.* A relay can be used to disconnect the charging circuit from the capacitor bank immediately after the discharge. The timing is accomplished by capacitor coupling a relay to the main capacitor bank. When the voltage on the main bank decreases (during discharge), the relay is operated, disconnecting the charging circuit until after the flashlamp has deionized. When the relay capacitor is discharged, the relay closes, reconnecting the charging circuit to the main capacitor bank, and the capacitors start to charge.

(*2*) *Constant Current Charging.* A constant current charging circuit can be used to decrease the charging time by a small amount.

(*3*) *Series Tube.* A mercury connectron or a hydrogen thyratron may be used in series with the flashtube to aid in deionization. The effect of these tubes is to increase the effective I_0 to a value of about 10 amp, thus decreasing the necessary charging time by as much as a factor of 10 or 20.

(*4*) *Inductive Charging.* With a critically damped RLC network for charging the capacitor, the available charging current immediately after discharge is quite low. This current must, however, remain below I_0 until deionization occurs. This is not a practical circuit for high-energy discharges since the energy storage capacity of the inductor must be one-fourth that of the capacitor bank.

Experimental Tests

A series of experiments on the limiting charging resistance were made by Robert Flieder on the EG&G FX-1 Flashlamp at M.I.T. for a thesis in the Electrical Engineering Department in 1954. Figure 5 shows those data replotted in terms of stored energy and limiting current, I_0. It is obvious that the simplified theory presented before applies only to a limited portion of the operation. For example, with a small energy such as 10 w-sec, the limiting current can be less than it is with the rated energy of 100 w-sec. The 5 kv data should be disregarded since the self-flashing voltage of the FX-1 tube is usually 4.5 kv.

Figure 6 shows a plot of the flashing rate of the FX-1 Flashlamp as a function of the w-sec loading. The solid line is calculated from the simplified theory of this paper. The circles are experimental data from Flieder's thesis, previously mentioned. Correlation is good over part of the range.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

Theory of Operation of Flash X-Ray Tubes

By J. S. McVEAGH

The operation of three-electrode, hard-vacuum, flash x-ray tubes is discussed, with particular reference to the use of these tubes in the so-called low-voltage circuit. It is noted that these tubes can give out pulses of x-rays which are very short compared with the "ringing time" of the associated electrical circuit.

A theory is put forward to explain this and other tube characteristics. The theory postulates the production of a plasma jet, which is "pumped" from the trigger arc towards the anode by means of the electromagnetic pinch effect. The x-ray exposure time corresponds to the transit time of this jet. The theory also requires that there should be an initial delay after the breakdown of the trigger before there is any appreciable rise of current in the tube. Some evidence of this is given together with some x-ray shadowgraphs illustrating applications of the flash technique.

1. Introduction

During a program of work in 1954 it was required to photograph small rapidly moving metallic particles inside an obscuring cloud of detonation products. For this purpose it was decided to construct flash x-ray equipment. The only readily available flash x-ray tube was the WL 389 which would operate on either a Marx generator circuit at 300 kv or a simple pulse transformer circuit at 40 kv.[1] Both circuits are shown in Fig. 1. It was decided to use the lower voltage circuit as it would penetrate the gas cloud and yet show up the fragments with good resolution. It soon became clear that although some good radiographs could be obtained using the low-voltage equipment, its performance was unreliable. In fact, some tubes would fail to give further output after as few as six firings. However, such tubes would continue in operation with good output at higher potentials up to several hundred firings. This phenomenon, together with the general variability of output of all flash x-ray tubes, has created a considerable interest in their mechanism. This memorandum describes the "plasma jet" theory of the operation of hard-vacuum flash x-ray tubes as put forward by P. T. G. Flynn,[2] in which the exposure time of the tube is governed by the transit time of a "plasma jet" between cathode and anode.

Current interest in thermonuclear research and highly ionized plasmas has led the author to suggest that the "plasma jets" described by Flynn may actually be driven across the x-ray tube by a "pinch effect" similar to that which occurs in ZETA.[3] Such a hypothesis accounts for most of the performance characteristics of flash x-ray tubes but needs more experimental confirmation.

Presented on October 18, 1960, at the Fifth International Congress on High-Speed Photography, at Washington, D.C., by J. S. McVeagh, Armament Research and Development Establishment, Sevenoaks, Kent, England.

2. The Operation of a Flash X-Ray Tube

2.1 — General

The output of an x-ray tube approximates to the equation

$$\Phi = KV^2I \qquad (1)^{[4]}$$

where Φ = x-ray intensity
V = anode potential
I = anode current
and K = a constant

In an ordinary x-ray tube the current may be of the order of 1 ma for 1 sec to blacken a film to a given level. Now the exposure time of a flash x-ray tube is of the order of 10^{-6} sec. The reciprocity law can be assumed, i.e.,

$$E = \Phi t \qquad (2)$$

where E = exposure and t = time

If the x-ray emission in such a tube was in the form of a square wave of voltage V, current I and duration 1 μsec, the current required to produce a similar exposure would be about 1000 amp. To supply currents of this magnitude in so short a time, the thermionic cathode of an ordinary x-ray tube must be replaced by a spark gap while the required current rise can only be delivered by a condenser.

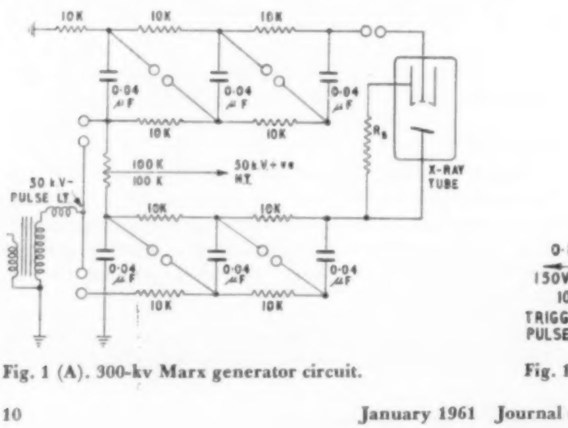


Fig. 1 (A). 300-kv Marx generator circuit.

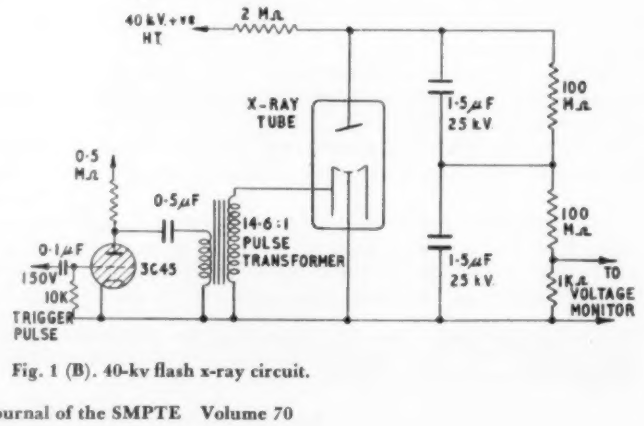


Fig. 1 (B). 40-kv flash x-ray circuit.

2.2 — The WL 389 Flash X-Ray Tube

It is convenient to describe the WL 389 flash x-ray tube here as it constitutes the basis of the discussion. Also, it is a typical hard-vacuum three-electrode tube and the only one in common use in England (Fig. 2). The anode is of tungsten as in an ordinary x-ray tube, in the form of an oblong block, but as mentioned above the thermionic cathode of an ordinary tube is replaced by a spark gap assembly. This assembly is made of stainless steel and consists of a cylindrical trigger electrode with a slitted concave end, into which a narrow flat plate cathode fits. Narrow gaps along the straight edges of both trigger and cathode electrodes are shaped so that two knife-edge spark gaps are connected in parallel.

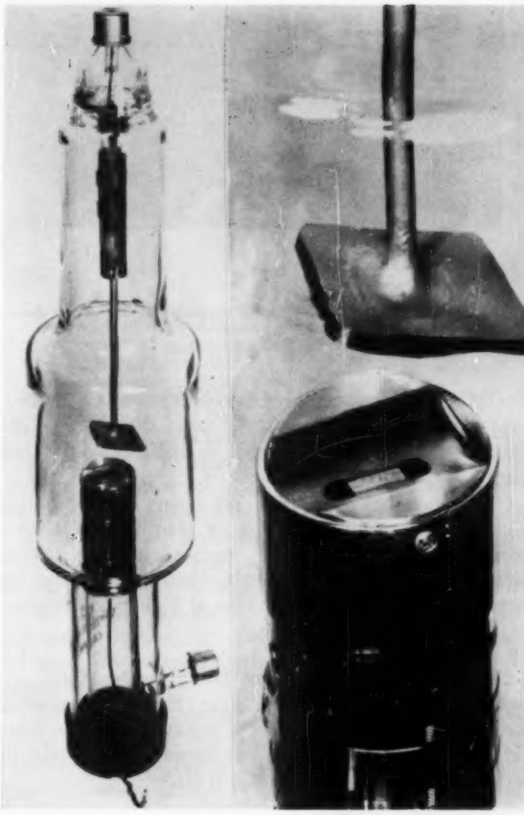


Fig. 2. WL 389 flash x-ray tube: left, general view; right, electrode system.

3. Current Theory of the Operation of Flash X-Ray Tubes

3.1 — Considerable work has been done since the end of the Second World War by various experimenters on the design and use of high-vacuum flash x-ray tubes and their associated circuits.[1,2,5] Few of these workers have presented theories that explain certain performance characteristics of such tubes. The main features to be explained are:

(*a*) The x-ray output of a hard-vacuum flash x-ray tube usually lasts 1 to 3 μsec, although the time for a complete oscillation of the associated circuit may be as long as 10 μsec.

(*b*) A hard-vacuum tube of this nature would be expected to be "space charge" limited to 60 amp or so, yet currents of 10^3 amp have been measured (Fig. 4). (The 60 amp has been calculated from the dimensions of the WL 389 using the "3/2" power law.)

(*c*) There is a delay after application of the voltage to the trigger system in emission of the x-ray flash. This effect is seen in Fig. 3: a hollow charge jet, the tip of which is travelling at 7.8mm/μsec, has passed through a pair of metal shorting screens. The first screen started an oscilloscope time base which began to record before the jet reached the second screen. The second screen triggered the flash x-ray and at the same time produced a pulse at the beginning of the time trace. Distances measured from this pulse to the steep current rise on the oscillogram, and from the second screen to the tip of the jet on the radiograph, represent the trigger delay. Some of the delay is due to thyratron-jitter (t_1), and the charging time of the capacitance of the trigger electrodes (t_2).

Now t_1 is about 0.2 μsec and t_2 has been measured and found to be approximately 0.3 μsec. Examination of Fig. 4, an oscillogram of the current discharge through the tube, shows no discernible increase in current until 4.5 μsec after the triggering of the pulse transformer thyratron. Thus 4 μsec have to be accounted for. This time, which is discussed later, the author attributes to the expansion of plasma during the formation of the discharge.

(*d*) The spectral distribution of a flash x-ray tube is very variable in both intensity and wavelength.

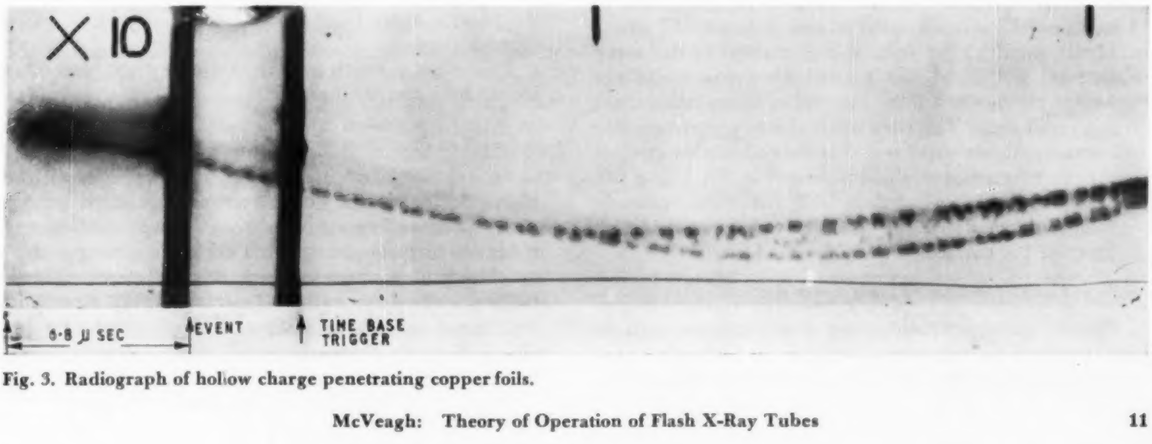


Fig. 3. Radiograph of hollow charge penetrating copper foils.

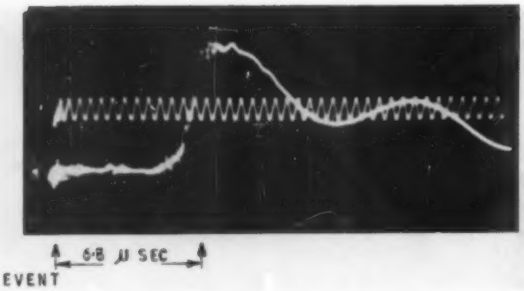


Fig. 4. Oscillogram of tube current during the exposure shown in Fig. 3, oscillation at 2 mc/sec.

(*e*) The work of several researchers shows evidence of x-ray outputs of less than 0.1 μsec duration.[5,7,8] Associated with these short flashes, is an improved sharpness of the radiographic image.

(*f*) X-ray tubes of the WL 389 type will work on low voltages of 40 to 50 kv using a simple pulse transformer circuit. However, they will operate only for a small number of flashes, as few as six, even though after this they will still operate successfully at higher potentials.

3.2 — The Plasma Jet Theory

Flynn[2] put forward a theory based on the emission of high-velocity "plasma" jets from the cathode which does a great deal to explain the behavior of these tubes. Similar theories have been put forward to explain the performance of arcs and sparks in air.[9,10,11]

His theory assumes that a plasma jet is produced by the evaporation of the trigger electrodes in the trigger arc. This plasma is a highly conducting medium whose presence reduces the distance over which space charge acts, thus rendering higher currents possible. It also acts as an electron source for the production of x-rays. The plasma has a high velocity, 10^6 cm/sec, towards the anode. (Values of plasma velocity of this order, in arcs, had been obtained by previous experimenters.[11,20]) This velocity controls the x-ray exposure time, which will be proportional to the anode cathode spacing. The inference is that when the plasma jet has crossed this space, it will reduce the tube impedance to a very low value so that anode potential will fall almost to zero. Without a high potential gradient to accelerate the electrons, there will be little further production of x-rays. It follows, therefore, that the exposure time is identical to the transit time of the jet. Thus, a tube of the WL 389 type will have an exposure time of 3 μsec since it has an anode cathode distance of 3 cm.

Flynn recorded the voltage and current of the x-ray flash tube. He found that the voltage across it did not fall appreciably for a fixed interval of time; then there was a rapid drop. The time interval was proportional to the anode cathode spacing and at the end of it the current had risen to a maximum of 10^3 amp (Fig. 5). Using this time interval in conjunction with the anode cathode spacing, he calculated the plasma velocity as being an average of 10^6 cm/sec.

3.3 — The Performance of the Trigger Arc

Flynn's theory explains tube characteristics such as the length of the exposure time and the high current in a hard-vacuum tube. However, it does not explain the variability of the x-ray output, the production of very short pulses of 0.1 μsec order, or the rapid failure of the WL 389 tube when working on certain "low voltage" circuits. It is the author's opinion that these unexplained characteristics are, to a large extent, functions of the trigger arc operation. This assumption is based on the known performance of various x-ray tubes, as well as the current theory concerning behavior of completely ionized gaseous plasma.

3.4 — Some Properties of Completely Ionized Gases and a Description of the Pinch Effect

3.4.1 — Langmuir defined an almost completely ionized gas as a plasma. Some of the properties of a plasma are described as follows.[12]

(*1*) The plasma is electrically neutral. Any tendency for the plasma to depart from neutrality is opposed by an automatically created electric field. For example, if electrons were removed from a blob of plasma leaving a net positive charge, an electrostatic field would be set up which would rapidly rise to a sufficient value to remove electrons from neighboring sources and so restore neutrality.

(*2*) There are short-range thermal collisions between particles of the plasma. These provide rapid transport for electric charges, and can give conductivities better than that of pure solid copper.

(*3*) The currents which can so readily flow in the plasma render it capable of reacting with magnetic fields. Hence, it can be compressed by them, and the presence of a plasma can modify a magnetic field. In general, a plasma tends to stick to lines of force and is repelled from positions of high field density towards positions of lower field density.

3.4.2 — The electromagnetic pinch effect[14,15,3] can occur in any highly conducting fluid, and has been used to pump liquid metals along pipes. In the present case a gaseous conductor is considered.

The plasma in which a pinch occurs can be considered as a highly conductive body similar to a metal. If current is induced to flow rapidly enough, a skin effect is produced which causes the current to flow in the outer surface of the conductor. The charges carried on the outer surface of the gaseous conductor will be shielded electrostatically from each other by the bulk of the plasma and will be little affected by their electrostatic fields. However, the currents flowing on the surface of the conductor will have magnetic fields. These will draw the outer surfaces towards the center, pinching the plasma against the internal thermal pressure of the gaseous particles.

This effect is much used in thermonuclear research to obtain high temperatures.

3.5 — The Production of High-Velocity Plasma Jets

As was described in Sec. 3.2, Flynn considered that high-velocity plasma jets (10^6 cm/sec) travelled between the cathode and anode of a three-electrode hard-vacuum tube. He further assumed that these jets were produced as a result of plasma expansion originally created in the trigger arc by evaporation of electrodes. His assumption was based on a hypothesis of Finkelnburg[11] that ions falling through the cathode fall of a mercury arc can transfer sufficient energy to the cathode to evaporate

metal off its surface as a high-velocity jet. It was also based on the work of Easton et al[20] in which jet velocities of 0.88×10^6 cm/sec were measured in an iron arc. However, such jets travel in a direction perpendicular to the cathode spot. This was demonstrated by Haynes[10] when he placed a blob of mercury on the side of a molybdenum rod electrode. In this case a plasma jet travelled in a direction perpendicular to the axis of the rod, and incidentally, perpendicular to the electric field. This latter effect demonstrates that plasma is little affected by electric fields.

In a flash x-ray tube the trigger spark path will normally be perpendicular to the electric field (Fig. 2). This is true of all x-ray tubes so far produced.

It is unlikely that jets produced by evaporation at the trigger cathode will have their main velocities directed towards the anode since the cathode spot will face towards the trigger electrode and not towards the anode. Unless some mechanism other than simple evaporation of the trigger electrodes is assumed, the only velocity towards the anode which plasma emitted from the trigger arc can have is "side splash." This motion would effectively be the expansion of a Maxwellian gas into a vacuum; therefore its maximum velocity could be equal to the velocity of sound in that gas. Calculations in Sec. 3.7 show that this will be about 1.2×10^5 cm/sec, an order lower than the velocity obtained by Flynn.

It might be suggested that a new cathode spot could be established in a direction facing the anode. However, modern theories of the cathode spot require a high current density in the spot.[11,16] Such densities can only be provided initially by field emission of electrons which requires an electrostatic field of 10^9 v/cm. Such a field can only occur at sharp points such as those between the trigger electrodes. In fact, care is taken to eliminate sharp points on surfaces facing the anode. Even if there were sharp points on the trigger electrodes, it would not be possible for high fields to develop between them and an adjacent highly conducting plasma, which would be connected to the trigger electrodes at the cathode spot.

3.6 — The Pinch Effect in a Hard-Vacuum Flash X-Ray Tube

If the discussion of Sec. 3.5 is accepted, a new mechanism must be found for the production of plasma jet velocities of 10^6 cm/sec.

A possible mechanism is put forward in a theory by H. Maeker.[13] This theory explains the production of high-velocity jets in carbon and other arcs as being due to "self-magnetic compression" of the plasma (i.e., the pinch effect) at a point near the cathode spot. This magnetic compression squeezes the plasma as fingers squeeze a tooth-paste tube, so that a jet of plasma is driven towards the anode at a high speed. The magnetic pressure will pinch the plasma until the internal and external gas pressures are equal. If the magnetic pressure is maintained, a jet will flow from this high-pressure region to the lower pressure regions nearer the anode. The pinch will act as a kind of magnetic pump. Again, if the pressure is to be maintained, plasma must flow into the high pressure point to replace that which is ejected in the jet. In an arc in air some or all of this new "working fluid" can come from the surrounding air, but in a vacuum arc it must all come from the trigger arc. It follows that a vacuum arc must be very sensitive to the amount of plasma produced by the trigger system.

3.7 — The Initial Trigger Delay

For an electromagnetic pinch to be established in a metastable state the electromagnetic pressure produced by collapsing currents must be balanced by internal thermal pressure in the gas.[12]

$$\frac{I_p^2}{2\pi a^2} = NkT = P \tag{3}$$

where

I_p = anode current in e.m.u. when a pinch is established
a = radius of the collapsing column in centimeters
N = number of charge carrying particles per cubic centimeter
k = Boltzman's constant
T = temperature in degrees Kelvin
P = pressure

Equation (3) gives the radius of the pinch which would occur in a given mass of plasma for a given temperature, current and ion density, assuming the rate of change of the current is sufficient to cause it all to flow on the outside. Since a flash x-ray tube reaches its maximum current of 10^3 amp in 1 to 3 μsec, the rate of change of current is 10^8 to 10^9 amp/sec. This should be quite sufficient to produce the high-frequency skin effect.

If the radius of the pinch is assumed, it is possible to calculate the corresponding current using numerical values as follows:

(*1*) The size of the trigger arc will tend to limit the initial diameter of the jet since it is the source of the plasma. The first pinch will occur at the point of minimum diameter. In the WL 389 tube the trigger gap is approximately 0.25mm across giving

$$a = 0.0125 \text{ cm}$$

(*2*) Robson and Von Engel[16] calculate the density of particles in the positive column of an arc as 10^{14} particles/cubic centimeter.

(*3*) The temperature of the plasma is a matter of some uncertainty. However, the temperature of the positive column of an iron arc has been measured as 6×10^3 K

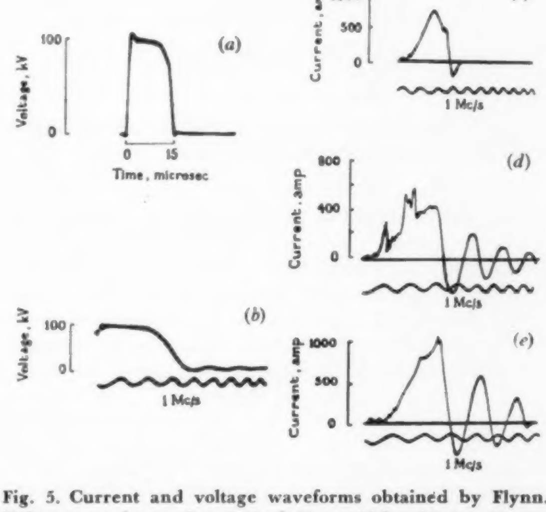


Fig. 5. Current and voltage waveforms obtained by Flynn. Voltage waveforms: $C = 0.01\ \mu$f, $V_0 = 100$ kv. (*a*) $d = 14$ cm; (*b*) $d = 3.5$ cm. Current waveforms: $C = 0.01\ \mu$f, V_0 100 kv, (*c*) $d = 4$ cm, (*d*) $d = 3.5$ cm, (*e*) $d = 2$ cm.

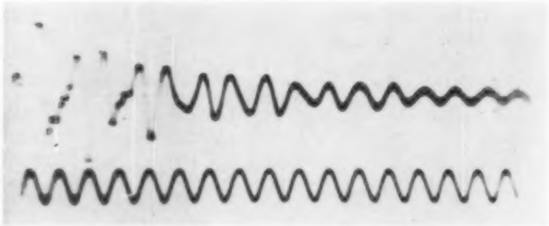


Fig. 6. Oscillogram of current through trigger arc differentiated. The oscillation on the lower trace is 10 mc/sec.

by Suits.[17] Other experimenters[11,17,18] have found values of the same order for the carbon arc.

These values may be put into Eq. (3) with

$$k = 1.38 \times 10^{-16} \text{ ergs/deg C}$$
$$I_p^2 = 2\,(1.25 \times 10^{-2})^2 \times 10^{14} \times 1.38 \times 10^{-16} \times 6 \times 10^3$$
$$= 8.07 \times 10^{-2}$$
$$I_p = 0.28 \text{ e.m.u.} = 2.8 \text{ amp}$$

If a hemisphere of plasma expands from the cathode arc, its surface will supply the electrons for the space charge limited current through the tube. This will flow approximately according to the Childs-Langmuir equation, for plain parallel electrodes.

$$j = \frac{1}{9\pi} \cdot \sqrt{\frac{2e}{m}} \cdot \frac{V^{3/2}}{d^2} \qquad (4)$$

where j = current density

$\frac{e}{m} = \frac{\text{charge}}{\text{mass}}$ of electrons

V = potential between electrodes

d = distance between electrodes

A correction can be applied to Eq. (4) for the finite size of the plasma hemisphere as follows:

$$j = \frac{1}{9\pi} \sqrt{\frac{2e}{m}} \cdot \frac{V^{3/2}}{d^2} \cdot \left(1 + \frac{r}{d}\right) \qquad (5)$$

where r is the radius of the hemisphere.

The value of r to give 2.8 amp can be found from

$$\frac{I}{2\pi r^2} = \frac{2.8 \times 3 \times 10^9}{2\pi r^2} = B\frac{V^{3/2}}{d^2} \cdot \left(1 + \frac{r}{d}\right) \left(\text{where } B = \frac{1}{9\pi}\sqrt{\frac{2e}{m}}\right) \qquad (6)$$

Putting d = 3 cm (the anode cathode spacing of a WL 389)

V = 100 kv

gives r = 0.23 cm = r_p, say

A pinch cannot occur until the plasma blob expanding from the cathode has reached at least this radius.

Now the velocities of the particles within the expanding blob can be assumed to be distributed in a Maxwellian manner since they are effectively the "side splash" of the trigger arc. The maximum velocity of expansion of a Maxwellian distributed gas into a vacuum is the velocity of sound in that gas. At these temperatures and pressures (if magnetic effects are ignored), the plasma will approximate a perfect gas, so that the velocity of sound

$$v = \sqrt{\gamma\frac{RT}{M}} \qquad (7)$$

In practice the vapor coming from the trigger arc will expand somewhat adiabatically so that the temperature will be considerably less than 6×10^3 K when the radius is r_p. However, if this value is used, it will give a maximum expansion velocity.

Assuming the gas to be monatomic $\gamma = 1.6$ and $M = 56$ for iron.

$$v = \left(\frac{1.6 \times 8.3 \times 10^7 \times 6 \times 10^3}{56}\right)^{1/2} = 1.2 \times 10^5 \text{ cm/sec}$$

From the previous discussion it is seen that a pinch effect cannot occur in the plasma advancing across a tube unless the current passing through it is greater than a certain level. In the case of a WL 389 type flash x-ray tube, this has been calculated to be 2.8 amp. According to the theory of space charge limited currents in a hard vacuum, this current cannot flow until the emitting surface is of sufficient size. In the case of the hemisphere and plane considered here, the hemisphere will have to have a surface radius of 0.23 cm to emit 2.8 amp. Until a pinch occurs in the plasma, there can be no "squeezing" effect to increase its velocity towards the anode so that its velocity can only be the "expansion" velocity of 1.2×10^5 cm/sec calculated above. It follows that there should be a delay between the formation of the trigger arc and the first pinching of the plasma. In the case of the WL 389 x-ray tube working at 100 kv this should be 1.9 μsec (Fig. 7). Some evidence for this has been obtained by Reikhrudel, et al.[6] who found that there was always a delay before the first rise of current.

Further evidence for this delay can be obtained from oscillograms of the current through a flash x-ray tube such as Fig. 8. This is the record of the current flowing through a WL 389 tube working at 40 kv with a capacity of 0.75 μf across it. The current was measured by means of a 0.065-ohm resistor, made of folded constantan tape, and connected in the cathode circuit. The record of current starts with a high-frequency oscillation which is so similar to the "time contracted" version of Fig. 6 that it can be assumed to represent the trigger arc current. If this is assumed to be superimposed on the main dis-

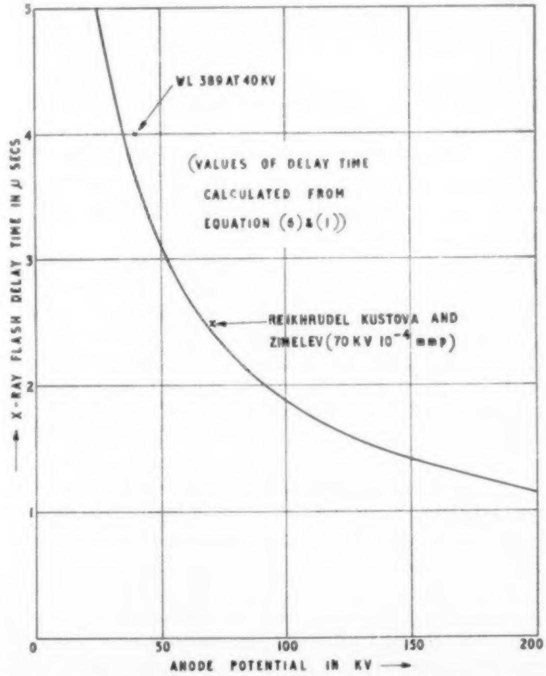


Fig. 7. Calculated curve showing variation of initial trigger delay with anode potential.

charge current itself, a line joining the mid-points of these oscillatory swings will represent the main discharge current. From this it is seen that there is no significant rise in the main current until 4 μsec after the trigger oscillation started.

This compares with 3.6-μsec delay calculated from Eq. (6). Figure 7 shows calculated values of delay for anode cathode potentials of a WL 389 x-ray tube between 25 kv and 200 kv.

3.8 — Operation of the WL 389 Tube in Simple "Pulse Transformer" Type Circuits

Failure of the WL 389 tube when operated in "pulse transformer" type circuits (Fig. 1B) commonly occurs after 6 to 20 operations. Failure occurs in one of two ways: one in which the trigger spark gap breaks down across the glass seal rather than across the gap between the knife edges; and another, in which the trigger gives a bright spark, but without a main discharge. The failure due to conduction over the glass has been overcome by the design of a new tube[19] which has a longer path length than that of the WL 389. (Solus Electronic Tubes Ltd. have produced this as Type TX 102.) However, the second type of failure still occurs even more readily in the TX 102 than it does in the WL 389. Since the electrode systems in the two tubes are identical, the most likely cause of difference between the two tubes is the vacuum level. This is borne out by the fact that the TX 102 will withstand potentials of 100 to 120 kv while the average WL 389 tube will support only 80 kv without breakdown. This suggests a higher gas pressure in the WL 389 than the TX 102. Now when these tubes are used in the pulse transformer circuit of Fig. 1B the trigger current is in the form of a high-frequency oscillation of the order of 10^7 cycles/sec (Fig. 6) which decays exponentially with time.

It is reasonable to assume that the emission of plasma will be a function of trigger current, and will stop when that current is low since energy must be supplied to the trigger arc itself at least to maintain losses by radiation. This break in the plasma supply would have little effect if it occurred before a pinch had been set up, since the plasma already formed will just expand at a reduced velocity. However, if the interruption occurred after a pinch had been set up the internal pressure inside the pinch would fall and the diameter of the pinched column would rapidly decrease under the effect of the magnetic pressure until a blob of plasma was nipped off. This would move away from the cathode at the high velocity produced by the "pumping effect" leaving a gap in the plasma column. Such a gap would have a high impedance to the flow of current through the tube since only space charge limited currents could flow across it.

Now, the conditions required for the production of a detectable pulse of x-rays are that the mass of plasma acting as a cathode should be close enough to the anode, and have a large enough electron emission for the space charge limited current to approach 10^3 amp, and again that there should be sufficient potential difference between the plasma and the anode to produce x-rays hard enough to get out of the tube envelope. The isolated blob of plasma would expand adiabatically as it crossed the tube so that its temperature, and hence electron emission, would fall and it would be unlikely to provide sufficient current. More important is the fact that its potential would rise towards the anode so that only a small potential difference would exist.

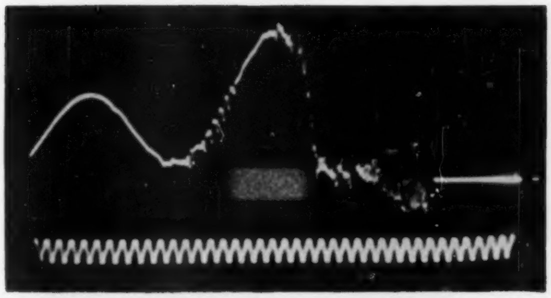


Fig. 8. Oscillogram of current through a WL 389 tube working at 40 kv with 0.75 μf.

From the previous argument it can be seen that failure of the trigger arc to provide a constant supply of plasma during an x-ray flash tube discharge may produce a gap in the plasma column and prevent any production of x-rays. Of course, if the gap in a plasma column should be closed by a second blob of plasma catching up with the first one, an x-ray flash would be produced since there would be a rapid rise of current upon the conjoining of the two blobs. At the same time the full anode cathode potential would appear between the plasma and anode.

It should be noted that tube failure of this kind does not occur with the Marx generator type of circuit (Fig. 1A). In this circuit there is a resistor connected between the anode and the grid electrodes so that there will always be a supply of current across the trigger gap while an anode cathode voltage exists.

Multiple triggering has been reported by some experimenters. Breidenbach[7] assumed that the multiple x-ray flashes he recorded were due to oscillations in the trigger circuit. He found that they could be prevented by the insertion of a resistance and inductance suitable to alter the period and damping of these oscillations.

The failure of the WL 389 tube in the pulse transformer circuit can be explained in terms of the cleanup of gas within the tube after successive discharges.[21] As the vacuum gets "harder" the impedance of the trigger gap will rise and more energy will be required to re-strike the trigger arc. The lengths of time during which the trigger is not producing plasma will get longer, as will the gaps produced in the plasma column crossing the tube, and they will be less likely to rejoin. After a few flashes, the gaps in the plasma column will no longer close in time and the tube will fail to produce x-rays.

3.9 — Fractional Micro-Second X-Ray Exposures and the High-Speed Pinch Effect

As mentioned in Sec. 3.1(e), many workers have obtained x-ray outputs of duration 0.1 μsec or less. Nearly all of these results were obtained with the WL 389 type of flash x-ray tube. An exception was Schaaffs and Trendelenburg who used a tube with a pointed anode surrounded by ring shaped trigger and cathode electrodes. However, in all cases the cathode anode spacing was very similar. Hence to obtain x-ray exposures of 0.1 μsec, plasma jet velocities of greater than 10^7 cm/sec were required. A mechanism is described here which would produce such velocities.

The high-speed pinch has been used in thermonuclear experiments to obtain required high temperatures.[22]

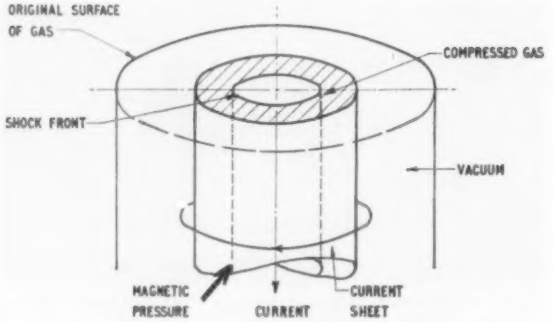


Fig. 9. Diagram of symmetrically collapsing high-speed pinch.

As described in Sec. 3.4.2, a mass of conducting gas is compressed by the self magnetic field by the current passing through its surface. In this case the current rises so rapidly that shock waves are driven ahead of it towards the center of the discharge, meet at the center and are reflected causing a rise in plasma temperature. A diagram of this is shown in Fig. 9.

In experiments and calculations which have been published,[23] it has been assumed that the high-speed pinch takes place in a parallel-walled cylinder. Thus, the shock waves would meet at the center of the discharge and be reflected in a planar manner. In most cases this will not be so; the shock waves will meet at the center at an angle as in Fig. 10. In long discharges or ones inside a toroid, the effect of such asymmetries will cancel out so that the assumption of planar reflection can be justified. In the case of a discharge of short length starting in a mass of plasma of circular cross-section but varying diameter as is shown in Fig. 10, the shock waves will meet at the center at an angle. In this case, a "Mach bridge" (AA) will be formed which will be a region of high temperature and pressure. This will discharge to the low pressure region along the axis to the left until a steady state is reached, then (AA) will tend to stay of constant length. To meet this requirement, (AA) must move to the left of Fig. 10, with a velocity of $U = V \cot \theta$ where V is the collapse velocity of the shock wave. If the angle is small, U can be very great.

This phenomenon is often encountered when dealing with shock waves produced by high explosives. Figure 11 shows the result of shock waves meeting at an angle within a cavity cut in a block of explosive. It can be seen from the streak camera record that the Mach bridge within the cavity travels at a velocity of 13.0mm/μsec compared with 7.75mm/μsec for the detonation wave, an increase of 68%.

In Sec. 3.8 it was suggested that high-impedance gaps would appear in the column of plasma crossing an x-ray tube if the trigger arc failed during transit time. It would be necessary for these gaps to close if there were to be an x-ray output from a discharge. The closure would produce a rapid increase of current through the tube. It is likely that this high rate of rise could form the initiating mechanism of a high-speed pinch, such as has been described above. It is significant that short x-ray exposures have been reported almost exclusively in connection with the pulse transformer type circuit.

4. Design of New Tube on Theory

The theory discussed in the previous sections shows that controlling factors of flash x-ray tube output and ex-

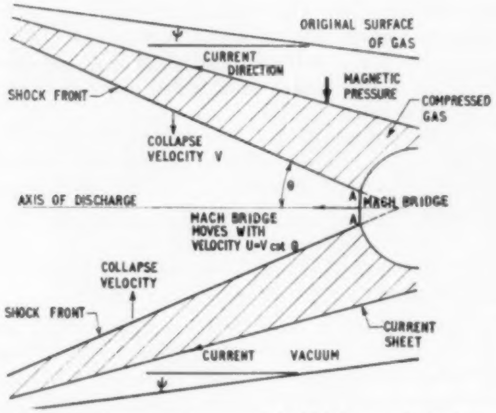


Fig. 10. Diagram of asymmetrical high-speed pinch.

posure time are the "dimensions" of the trigger arc — that is, the shape, temperature and pressure of the plasma which forms between the trigger electrodes, together with its continuity in time. It is not surprising therefore, that x-ray tubes produced up to the present time have been variable in output since they have all relied on a trigger arc formed between some type of knife-edge spark gap. A knife-edge spark gap is forced to produce a spark at a different point, and of a different length, at each discharge since the original point of lowest impedance will have burnt away. A needle gap would be even worse as its separation will increase with each discharge. A ball gap will be a little different from a knife edge and very difficult to initiate in a hard vacuum. Figure 12 shows a possible tube design with a new triggering system that might eliminate some of these difficulties.

The knife-edge gap has been removed from the main discharge to an external gap at CD. The plasma source for the main discharge is a fine hole in a third disc-shaped electrode B, so that the source of plasma will be of fixed size and shape.

The operation of the trigger circuit is as follows: the pulse transformer will charge up the condenser C_1 via the small ancillary gap CD. Radiation from CD will ionize any molecules between C and B. When the potential between C and B has risen sufficiently high, CD will form the source of plasma for a discharge from C to B. When the plasma reaches B it will pass through the hole to form a source for the main gap. Maecker describes the use of a pierced plate such as this to form an "artificial pinch," hence, it follows that plasma entering the main gap will already be in a pinched form with a high velocity towards the anode — a velocity which will be maintained as the current rises rapidly to satisfy Eq. (3). The jet of plasma will act as the cathode for the main discharge, as usual, and will end the production of x-rays on reaching the anode.

5. Conclusions

A pinch effect can be the mechanism which pumps plasma from the cathode to the anode of a flash x-ray tube and which forms the electron source during the production of x-rays. The initial "tube triggering delay" of a flash x-ray tube can be explained as the time during

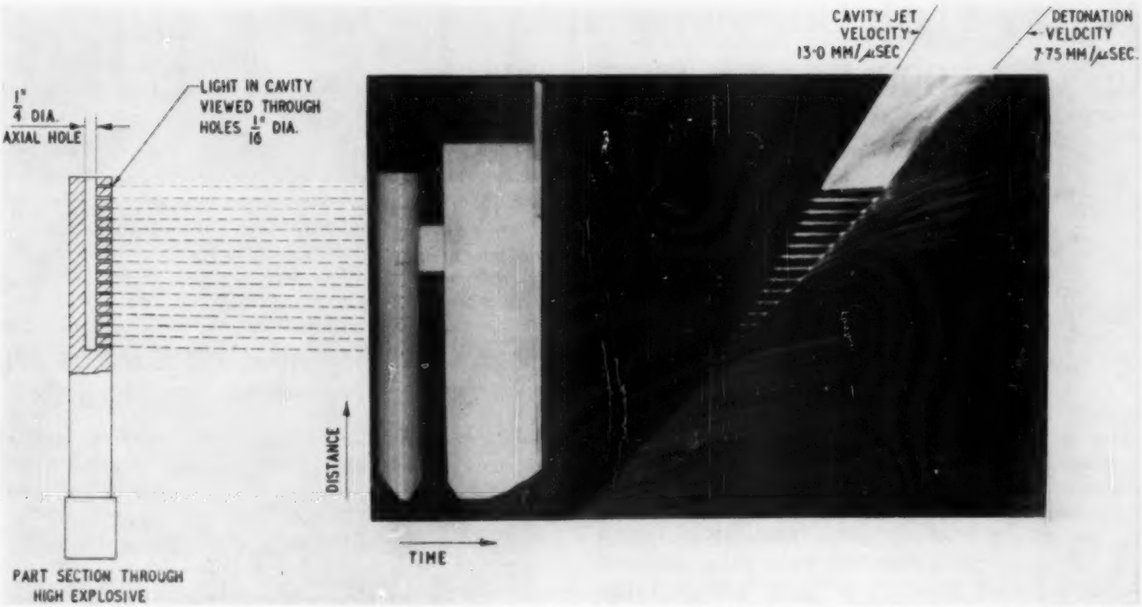


Fig. 11. Streak camera record showing a high-velocity jet produced by collapsing shock waves inside a cavity drilled in a high explosive (RDX/TNT).

which the space charge limited current of the tube must increase before a pinch can form. Calculations of this time from theory are in reasonable agreement with practical values.

Failure of tubes of the WL 389 type can be explained as being due to failure of the trigger arc when the plasma jet will pinch through and so produce a high-impedance region in the tube which can inhibit the production of x-rays. The fact that tubes will work at low voltage for a limited number of discharges and then fail is explained by the size of this insulating gap being dependent upon the residual gas in the tube, i.e., upon the failure time of the trigger arc. Each discharge "cleans up" a certain quantity of gas until a point is reached when the insulating gap does not close.

The closing of this gap can produce the "high-speed pinch" effect by which plasma jets can be shot across the tube at velocities greater than 10^7 cm/sec, causing x-ray outputs of less than 0.1 μsec duration.

6. Acknowledgments

I wish to thank H. J. James for his encouragement, helpful discussion and suggestions.

7. References

1. C. M. Slack and L. F. Ehrke, *A.S.T.M. Bull*, *150:* 1, 1948.
2. P. T. G. Flynn, *Proc. Phys. Soc.* (B), *69:* 748, 1956.
3. P. C. Thonemann et al., *Nature*, *181:* 217, 1958.
4. W. T. Sproull, *X-Rays in Practice*, McGraw-Hill Book Co., New York, 1946.
5. W. Schaaffs and F. Trendelenburg, *Z. Naturf.* 3A, 656–668, 18.3.1948, (Trans. TIB/T4348).
6. E. M. Reikhrudel, A. V. Kustova and A. G. Zimelev, *Zhurn, Tekh. Fiz.* *24:* (7), 1179–1186, 1954.
7. H. I. Breidenbach Jr., *Rev. of Sci. Inst.*, *20:* No. 12, 899–903, Dec. 1949.
8. E. L. Criscuole and D. T. O'Connor, *N.O.L. Navord Report*, 2338: Feb. 1952.
9. A. Schuster and C. Henisalech, *Proc. Roy. Soc.*, *64:* 331, 1899.
10. J. R. Haynes, *Phys. Rev.*, *73:* 891, 1948.
11. W. Finkelnburg, *Phys. Rev.*, *74:* 1475, 1948.
12. R. F. Post, *Revs. Mod. Phys.*, *28:* 347, 1956.
13. H. Maeker, *Z. f. Physik*, *141:* 198–216, 1955, (Trans. AEI T/895).
14. W. H. Bennett, *Phys. Rev.*, *45:* 890, 1934.
15. L. Tonks and W. Allis, *Phys. Rev.*, *56:* 360, 1939.
16. A. E. Robson and A. Von Engel, *B.E.A.I.R.A. Tech. Rep. L/T367*, 1958.
17. C. G. Suits, *Physics*, *6:* 190, 315, 1935.
18. L. S. Ornstein, *Physics*, *1:* 797, Lit. 817, 1934.
19. G. G. Pollitt, *War Office Unpublished Report*, 1956.
20. E. C. Easton, et al., *Elect. Eng.*, *54:* 1454, 1934.
21. S. Dushman, *Scientific Foundation of Vacuum Technique*, Ch. 10, Sect. B: John Wiley & Son, New York, 1949.
22. S. C. Curren et al., *Paper No. P/1460*, Geneva Conf. 1958 on the Peaceful Uses of Atomic Energy.
23. J. D. Jukes, *U.K.A.E.A. Report GP/R 2293*, 1958.

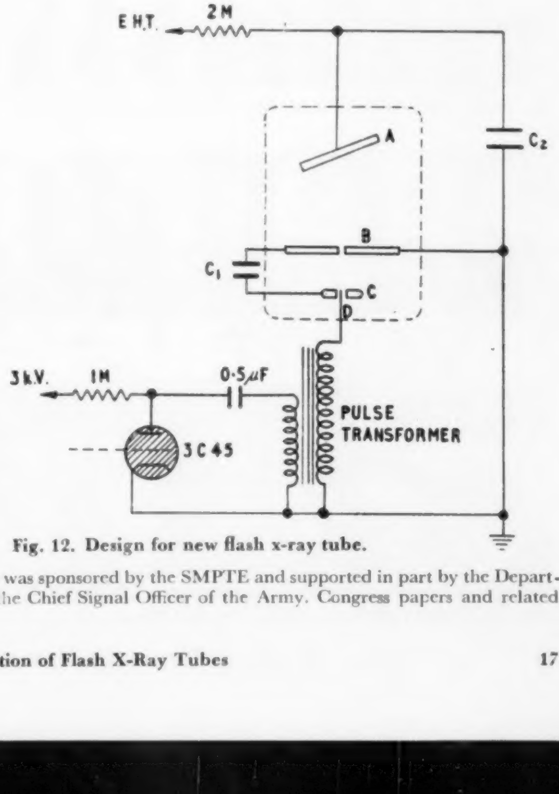


Fig. 12. Design for new flash x-ray tube.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

X-Ray Flash Cinematography up to 12,000 Images/Sec

By A. STENZEL
and G. THOMER

In a continuation of experiments reported at the last High-Speed Congress (1958) the authors study the conditions that determine the maximum frequency of periodic discharges through a flash x-ray tube. With the earlier device, using direct triggering of the tube and simple R-C or R-L-C recharging, the limit frequency is about 5000/sec. To get a higher rate, it is necessary to isolate the anode from the discharge condenser during the pauses.

In the new circuit this controlled separation is attained by a quenched spark gap, which is periodically triggered by an electronic pulse generator. The device allows a precise control of frequency and total frame number. A capacitive voltage divider assures the synchronized pulses to the tube trigger electrode. With an apparatus following this principle, periodic x-ray flashes up to 12,000/sec and a total number of 60 were produced. Image separation is accomplished by means of a drum camera running at 80 m/sec. As applications, the authors show a frame series of the initiation of a squib and of the liquid metal transition in arc welding.

To record a fast event by cineradiography at high frequencies, several individual flash sources, or one tube with repeated flashes, may be used. These two techniques have been reported in several papers, and each of them has found its field of application. Although equipment having several tubes with individual pulse circuits is rather expensive, especially at higher voltages, nevertheless, it has sometimes been used.[1] For this technique the upper frequency limit is obviously given only by flash duration and could therefore be pushed today up to 10^7/sec. A disadvantage of this method is the limited number of frames. Apparatus described to date has no more than eight flash sources. Moreover, parallax is sometimes a handicap. The repeated-flash technique obviates these disadvantages, but entails difficulties with respect to obtainable frequency and image separation.

At the Fourth Congress on High-Speed Photography in 1958, experiments with low voltages were reported.[2] Flash series of 5000/sec could be obtained. Since that date we have continued experiments in order to increase (a) the frame frequency and (b) the applied voltage (and hence the hardness of radiation).

Higher Frequencies at 30 kv

One of the earlier[2] reported circuits has been modified as shown in Fig. 1. Its crucial part is a special quenched spark gap working in a hydrogen atmosphere as proposed by Vollrath,[3] Stenzel[4] and Früngel.[5] This gap consists of 80 carefully machined and cleaned copper electrodes with central holes. They are insulated from each other by plastic rings to give a gap width of 0.15 mm and an active electrode surface of 1.2 sq cm. The complete pile is mounted in a glass tube with brass end plates and sealed by O-rings. A mercury manometer indicates gas pressure, maintained at 80 mm Hg above atmospheric, to prevent the entrance of air. One of the middle electrodes is connected with a wire sealed in the glass for frequency control. An R-C network parallel to the spark gap ensures a symmetric potential re-increase, avoiding unwanted firings.

As described in earlier papers a continuously evacuated three-electrode flashtube with conical copper anode and cellophane window was used. The reliability of the tube trigger circuit was improved by adding condensers to the resistance chain. The discharges are controlled by pulses to the previously mentioned trigger electrode of the spark gap. They are produced by an amplitude-controlled pulse generator. A special device limits the number of frames and allows synchronization with the phenomenon. With this installation, a series of 60 flashes at frequencies up to 12,000/sec could be obtained. Higher frequencies seem to be possible. No efforts were made to increase the frequency further, since image separation set a practical upper recording limit of about 10^4/sec. As in earlier tests, a Leybold drum camera, running at a maximum speed of 90 m/sec, was used for image separation.

Tests at 120 kv

The circuit of Fig. 1 may also be used for higher voltages, provided that condensers and resistances are suitably chosen. We preferred, however, a voltage-

Presented on October, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by A. Stenzel and G. Thomer (who read the paper), Institut Franco-Allemand de Recherches, St.-Louis, France.

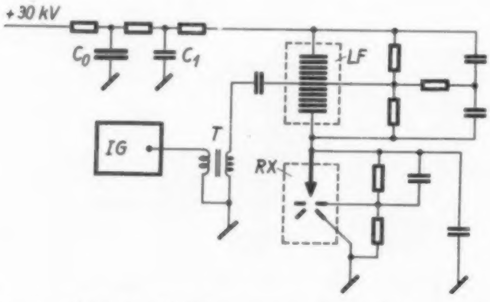
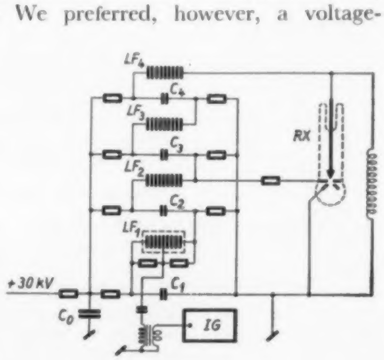
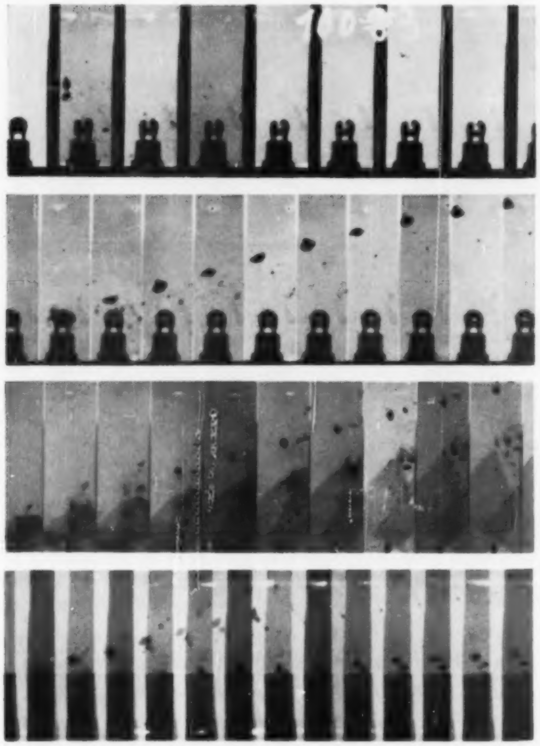


Fig. 1. Circuit for high-frequency x-ray flash cinematography at 30 kv. C_0 storage condenser; C_1, discharge condenser; *LF*, quenched spark gap in hydrogen; *IG*, pulse generator; *T*, pulse transformer; *RX*, x-ray flashtube.

Fig. 2. Circuit for x-ray flash cinematography at 120 kv. C_0, storage condenser; C_1, C_2, C_3, C_4, discharge condensers; LF_1, quenched spark gap in hydrogen; LF_2, LF_3, LF_4, quenched spark gaps in air; *IG*, pulse generator; *RX*, sealed-off x-ray flashtube.





Figs. 3–6 (from top to bottom). Behavior of electric caps (squibs) at different frequencies. Figs. 3 and 4; electric cap on its own; 1000 and 6000 images/sec, respectively. Figs. 5 and 6; electric cap with powder set; 9000 and 11,000 images/sec, respectively. Voltage: 30 kv. Distance, source to film: 25–30 cm. Film: Kodak "Kodirex" without intensifier screen.

multiplying device as shown in Fig. 2, consisting of four stages of capacitors charged in parallel and discharged in series. All spark gaps are of the quenching type, but only the first is hydrogen-filled. This is sufficient for the present frequencies as the later stages are fired far over the static breakdown voltage. Only the first gap is working under critical conditions. In the future for increased frequencies, hydrogen gaps will generally be used.

The x-ray flash source used for the 120-kv experiments was a sealed-off Pyrex glass tube with tungsten anode, developed and manufactured in the Institute laboratory.[6] Image separation was performed in the same way as for the 30-kv tests. Film blackening, however, was remarkably increased by cementing a flexible intensifier screen (Auer "HV") on the drum surface.

Application Examples

Figures 3–6 are selected parts of cineradiographic records showing the behavior of electrical fuses and squibs. Experimental data are shown in the legends. For Figs. 3, 4 and 6, the x-ray pulse source and the fuse were fired by an external controller which incorporated a delay device. For Fig. 5 we obtained synchronization by using two aluminum foils short-circuited by the projected burning particles, as in this case dispersion of response time was too great. These powder-driven aluminum foils can be distinguished in Fig. 5.

Another interesting field of application of cineradiography is in electric arc welding, where material transport phenomena can be visualized. As reported in the detailed monograph by Conn,[7] optical cinematographic methods have already been extensively applied in this field. Optical records, however, are less able to give information about material transport because of the

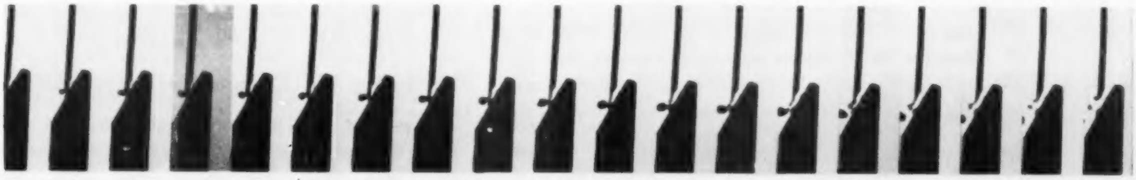


Fig. 7. Arc welding, a bare iron electrode in air held in an oblique position relative to the work piece. Voltage, 30 kv; frequency, 2000 images/sec.

Fig. 8. Arc welding, covered electrode. Arc voltage, 60 v; arc current, 90 amp; x-ray pulse voltage, 120 kv; frequency, 1000 images/sec.

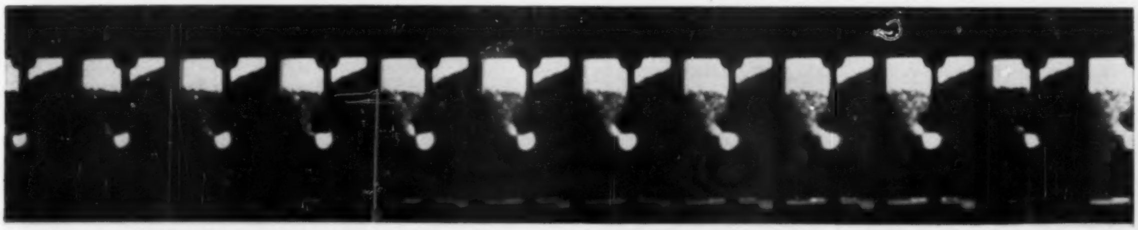


Fig. 9. Arc welding under powder. Arc voltage, 60 v; arc current, 120 amp; x-ray pulse voltage, 120 kv; frequency, 1000 images/sec.

very bright self-luminescence of the arc. Furthermore, it is of course not possible to use optical recordings when studying the techniques of welding under powder nor is it possible to look through the cover when using covered electrodes. In such cases x-ray cinematography gives valuable supplementary information. Figures 7–9 show three examples of drop formation and material transport in arc welding.

Conclusions

Film-transport speed (~100 m/sec for an exterior film on a drum) limits the product of image width and frequency. X-ray flash frequencies achieved today (10,000–12,000/sec) make it necessary therefore to reduce the image width to 8–10 mm. Further work in this field will therefore require other optical and electronic arrangements; e.g., one might photograph a fluorescent screen. It would seem that a particularly valuable technique would involve the application of an image intensifier. The succeeding paper treats this subject.[8]

References

1. W. A. Zuckermann and M. A. Manakowa, "Röntgenblitzquellen zur Untersuchung schnellverlaufender Vorgänge," IV. Int. Kongr. f. Kurzzeitphot. u. HF-kinematographie, Köln, 1958.
2. G. Thomer and A. Stenzel, "Versuche zur Röntgenblitzphotographie mit weicher Strahlung," *Ibid.*
3. K. Vollrath, "Messung der Entionisierung an elektrischen Funkenstrecken," *Proc. 2d International Congress on High-Speed Photography*, Dunod, 92 rue Bonaparte, Paris 6, 1956.
4. A. Stenzel and K. Vollrath, "Chronoloupe électronique à étincelles fournissant un grand nombre d'images," *Ibid.*
5. F. Früngel, *Impulstechnik*, Akad. Verlagsges., Leipzig, 1960.
6. G. Thomer, "Etudes récentes concernant les appareils pour radiographie-éclair et radiocinématographie ultra-rapide," *Proc. 2d International Congress on High-Speed Photography*, Dunod, 92 rue Bonaparte, Paris 6, 1956.
7. W. M. Conn, "Die Technische Physik der Lichtbogenschweissung," Springer-Verlag, Berlin-Göttingen-Heidelberg, 1959.
8. G. Thomer and R. Schall, "Application of image intensifier in flash radiography," the succeeding paper in this publication.

Application of Image Intensifier in Flash Radiography

By G. THOMER and R. SCHALL

For certain applications of flash radiography, particularly diffraction studies, the x-ray intensity of a single flash is not sufficient for direct photographic registration. A further increase of flash specific intensity is not to be expected because of the limited current density at the anode and the required short flash duration, so an improvement of sensitivity of registration might be expected to open new fields of application to flash radiography. One possibility of realizing this is given by the electronic x-ray image intensifier. The authors study the possibilities of application of such a device in flash technique.

A slight loss in definition must be accepted, but this is nearly the same as in the stationary case. The image blur due to development of space charge in the electron optics by high impulse loads is negligible for dose rates up to 10^5 roentgen/sec. Using an objective of extremely high aperture and highly sensitive film, the gain in sensitivity is about a factor of 50, compared with direct registration using a highly sensitive film. The method will be of interest not only for single-flash photography but also for cinematography with x-ray flashes.

As in optical high-speed photography, the development of flash radiography depends not only on the production of shorter intense flashes, but also on improvement of the recording medium. Flash radiography benefited in the last two decades mostly from the development of intensifier screens and of emulsions of higher speed. For certain applications, however, the intensity of a single flash is not sufficient to blacken a film. For example, diffraction studies with x-ray flashes, undertaken by Schall[1] and Schaaffs,[2] have, for intensity reasons, hardly found practical applications until now, though there are interesting problems that await solution, particularly in dynamic strength phenomena. Another field where there is a desire to increase the recording sensitivity is the submicrosecond exposure range. Today x-ray flash sources with a flash duration of 10^{-7} sec are available; and — just as for visible light photography — efforts are being made to reduce this time to a few millimicroseconds. The development of the source needs to be paralleled by an improvement of the recording system.

One possibility for increasing the recording sensitivity in radiography is given by the image intensifiers which have been available for several years. As these intensifiers were originally built for static use, this paper is concerned with the examination of their applicability in flash techniques. Here two basic questions arise: (1) Will the electron image, at high impulsive currents, be troubled by a space charge which could induce image distortions or loss of definition? (2) What is the practical gain in sensitivity for flash radiography?

Instrumentation

Tests were run with a Philips Image Intensifier for material testing built by C. H. F. Müller, Hamburg, type MB 12. Its input screen has a diameter of 135 mm, and the output screen is a yellow-green phosphor with a diameter of 14 mm. For visual observation, a Zeiss binocular microscope was used. For the photographic records, we used a Contaflex Camera (Tessar $f/2.8$) or a

Presented on October 18, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C. by G. Thomer (who read the paper) and R. Schall, Institut Franco-Allemand de Recherches, St.-Louis, France.

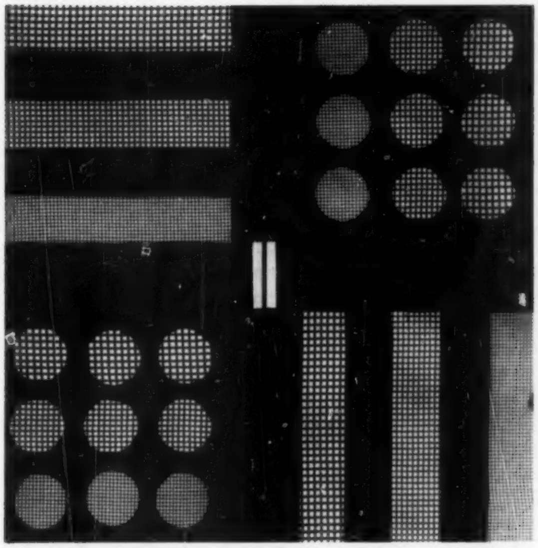


Fig. 1. Contact print of the test grid with continuous x-ray illumination on high-definition x-ray film (Kodak Film Type M); exposure, 500 milliroentgen.

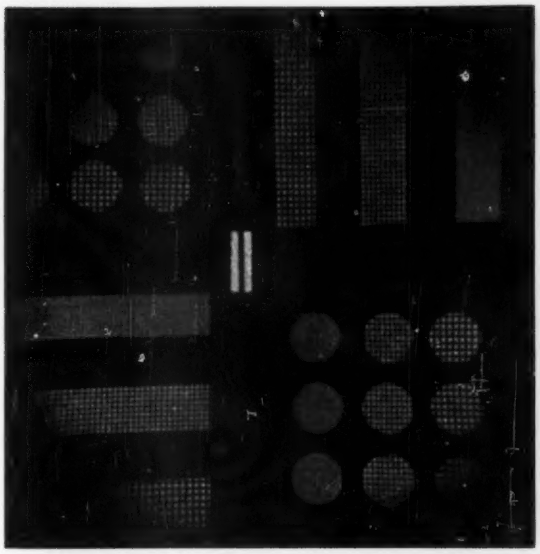


Fig. 2. The test grid taken with an electronic image intensifier and a Contaflex Camera; continuous x-ray illumination (0.4 milliroentgen); size of picture on the film, 12 mm diam.

Zeiss-R objective lens ($f/0.85$) adapted to a Foca Camera. As a static x-ray source, a medical equipment (80 kv, 5–20 ma) was available. As a flash source, we used a 1-Mv impulse generator (10 stages) with a sealed-off glass tube, built in our laboratory. For comparison purposes, the flash installation was run at 100–300 kv.

Image Definition

In order to investigate the image quality for definition and distortion, we used a test grid with areas of different mesh distances. Figure 1 shows a direct radiograph of this grid, recorded on a film of high definition (Kodak Type M) without intensifier screens. The grid spacings are 0.75 mm, 1.25 mm and 1.5 mm. The clear central area is useful when focusing the electron lens of the intensifier. This focus is set using the binocular microscope and continuous radiation. The microscope is then replaced by the camera, which is focused with the aid of the reflex mirror. With our experimental arrangement, the image diameter on the film was 12 mm. A record of our test grid, obtained in this way with continuous x-radiation, and enlarged to the original size, is given in Fig. 2. It is obvious that some detail is lost, and that the edge of the image is distorted. The definition in the central area is nevertheless sufficient ($\sim$0.6 mm), especially when compared with a direct radiograph using intensifier screens of high intensification factor, as shown in Fig. 3.

To study the influence of flash illumination, flash radiographs were taken at 120 kv and at different distances of the intensifier from the x-ray source. Figure 4 shows the experimental arrangement. For these records the image converter is used with its normal static acceleration voltage. By variation of the distance from the flashtube, a convenient mean film blackening is obtained which allows a comparison between the flash record and the static record. Figure 5 shows such a converter-intensified flash record. It seems that there is no essential difference between the pulsed and the static record. Flash duration is 0.5μ sec, and x-ray dose rate falling on the photosensitive converter screen corresponds to about 10^3 roentgen/sec. Even for still higher dose rates—i.e., for smaller distances from the source—no essential loss in definition could be noted, if the aperture of the lens was chosen to obtain a suitable film blackening.

Intensification Factor

Manufacturers of x-ray intensifiers indicate intensification factors of the order of 10^3. This factor means the

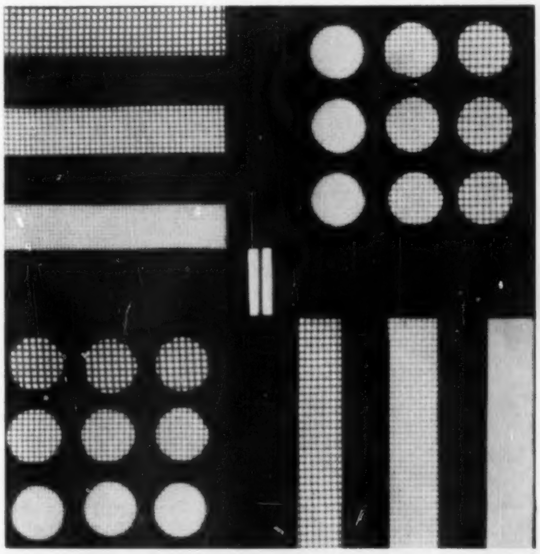


Fig. 3. Contact print (flash illumination, 200 kv, 0.5 μsec) on high-speed x-ray film (Kodak Regulix "HS") between intensifying screens ("Fulgurix" by the Compagnie de Radiologie); exposure, 2 milliroentgen.

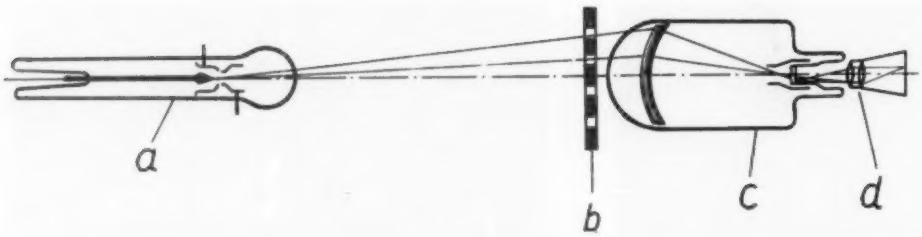


Fig. 4. Experimental arrangement: a, x-ray flashtube; b, test grid; c, image intensifier; d, camera.

gain in brightness of the fluorescent screen of the intensifier compared with that of a screen illuminated directly by x-rays. This includes the increase in luminosity due to the electron optical size reduction, and the intensity increase by electron acceleration.

For high-speed measurement this radioscopic intensification factor is less interesting than the radiographic factor resulting from a comparison of a direct x-ray record and a record of the intensified image. It is obvious that this comparison depends not only on the qualities of the image intensifier, but also on those of the films, the intensifier screens and the camera used. In fact, the intensification factor not only is an index of the performance of the image intensifier, but also it reflects the actual relative state of visible-light photography and radiography.

The camera aperture is of course of great influence. We used the R-Biotar $f/0.85$, which was particularly designed for fluorescent screen photography. Because of the geometry of the apparatus, the images of the screen on the film had to be reduced 3:1, so that the final images were only 5 mm in diameter. This means that, due to the photographic grain size, losses in definition arise, depending on the film used.

The intensification factor of our system was determined as follows: the blackening of high-speed x-ray film between intensifier screens (CGR "Fulgurix") was compared with the blackening of a Scopix film in a camera with the Biotar lens focused on the intensifier screen.

This factor F is obtained from a series of exposures: $F = (r_1/r_2)^2$, where r_1 is the distance, source to film, giving an absolute blackening, $s = 0.8$; and r_2 is the distance, source to image intensifier, giving the same blackening s. In these series, flash conditions were of course held constant; and flash intensity dispersion was eliminated by taking average values. Reduction of x-ray intensity was achieved by varying the distance of the recording device from the x-ray source. Under these conditions we obtained F values of between 40 and 64, depending somewhat on processing conditions. Thus there is a considerable gain in intensity making possible many new applications, accompanied, however, by a small loss in definition. As in visible-light flash technique, a choice must be made between highest sensitivity and best definition.

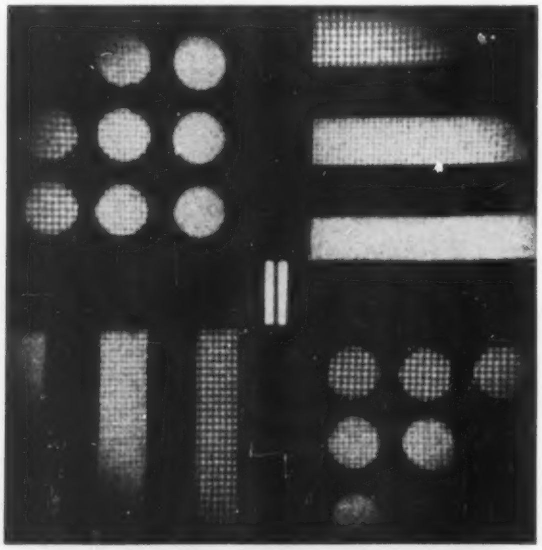


Fig. 5. X-ray flash picture (120 kv, 0.4 milliroentgen) with electronic image intensifier and Contaflex Camera; size of picture on the film, 12 mm diam.

Conclusion

X-ray image intensifiers are convenient for recording fast events, provided that highest definition is not necessary. For impulsive use, definition is not remarkably worse than for static or continuous radiation. Using an $f/0.85$ lens, one obtains a gain of intensity of a factor of 50 compared with a direct record on x-ray film.

The gain in intensity enlarges the field of application of flash radiography, particularly for records with extremely short exposure times, and also for diffraction records. The transformation of the x-ray image to an optical one is especially worth while in flash cineradiography. In the direct recording of cineradiographs, with presently attainable flash frequencies of the order of 10^4/sec, and modern drum cameras, the image height can hardly be greater than 1 cm. Thus, normally, image separation could be achieved only at higher repetition rates by reduction of frame size.

The image converter effects a size reduction, easily giving at the same time an intensification. Flash cinematographic series could therefore easily be obtained by means of the image intensifier by filming the converter screen with a high-speed camera of the Fastax type, flash triggering being controlled by the camera.

References

1. R. Schall, "Feinstrukturaufnahmen in ultrakurzen Zeiten mit dem Röntgenblitzrohr," *Z. angew. Phys.*, *2:* 83–88, 1950.
2. W. Schaaffs, "Die Erzeugung von Röntgenblitzinterferenzen von polykristallinem Material," *Z. Naturforsch.*, *5a:* 631–632, 1950.
3. M. C. Teves and T. Tol, "Elektronische Verstärkung von Röntgenbildern," *Philips Techn. Rundschau*, *14:* 37–47, 1952.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

Electronic Brightness Contouring

By R. L. HALLOWS

An unorthodox circuit technique is described, in which a standard pentode amplifier is operated "below the knee" of the plate characteristic to obtain a reversal of transfer characteristic slope. Projecting selected amplitude increments of a video signal over this reversing characteristic and deleting remaining video portions not in the immediate vicinity of the reversal, results in a signal having "off" response to levels on *both* sides of the input incremental level and a suprisingly well defined "on" response to the included level. The contour or "outline" signal thus derived may be added to the input signal to form a composite display in which the level of the contour may be continuously varied for observation or analysis.

The electronically processed photographic rendition of the skycraper scene in Fig. 1 is composed of lines and areas which represent a discrete and narrow range of brightness in the original subject. Intensity and polarity (black or white) of the outline signal generated by the video device to be described may be quickly and continuously adjusted throughout the tone scale of the picture under study. The device produces equal brightness contours, or outlines which are analogous to the familiar elevation contours on a topographic map, or the "isobars" on a weather map. These outlines may also be viewed in superposition with the conventional representation of the scene from which it is derived.

For photo interpretation purposes it is less confusing to provide only one contour, since the ease with which the analyst may vary its represented brightness level gives a more complete "feel" for the brightness contouring of the subject than would the generation of multiple fixed contours.

This apparatus may be useful in quick evaluations of brightness distributions of nebulous objects such as clouds, or in optical or astronomical "star images" when used with rough calibration techniques.

Outliner Concept and Circuitry

In a standard video amplifier with keyed grid clamping, oscilloscope observations indicated that when the clamp disconnect diodes were removed so that the amplifier tube operated without a grid leak the output signal "folded over" in such a way that some portions of the video signal were of the expected inverted polarity, as in negative bias operation, and other portions were uninverted, corresponding to positive control grid operation.

In the partially inverted video display a fine white outline occurred on transitions between inverted and normal video polarity. This was observed on some transitions which ran parallel to raster scanning lines. Further investigation provided an explanation for this seemingly impossible phenomenon.

A sharp vertical transition did not result in a white outline when it lay between scanning lines, but did so only when it intersected a scanning line. Slight defocusing of the input slide increased the probability of intersection and, under this condition of smoothly changing intensity in the subjects, provided continuity of the outline, both horizontally and vertically.

Stability was obtained in the circuit (shown in final form in Fig. 2) by providing a high-resistance control grid return to the plate supply voltage. It was found that the tube could be operated well within its dissipation ratings and still provide the outline spikes, provided the screen voltage was greater than the plate voltage.

Generating Tube Operation

Measurements of static transfer characteristics (Fig. 3) on the outliner circuit show that a reversal of slope in plate current occurs with positive control grid drive. Since both plate circuit resistance and the rate at which its accelerating field decreases are greater than those of the screen grid, this reversal occurs when the plate circuit impedance is made significantly higher than that of the screen grid. Beyond the minimum plate voltage point, the screen grid attracts an increasing proportion of electrons emitted from the cathode, so the plate voltage rises — perhaps in protest.

It is unlikely that secondary emission from the plate contributes to this reversal as it does in a dynatron oscillator, since the effect was observed with the suppressor grid operating at -300 volts. Furthermore, the effect was lost when the tube was operated as a tetrode (to favor dynatron operating conditions strongly) with the suppressor returned to the screen voltage supply.

For small magnitudes of input voltage, the plate signal is an uninverted replica of the grid signal by virtue of operating in the diminished plate current region in which a negative change in grid voltage produces the described increase in plate current.

The control grid is operated in grid-current clamp fashion, with the exception that it is returned through a high resistance to the B+ source instead of to ground as is customary. It therefore assumes a relatively heavy equilibrium current of about 20 μa.

Consequently, the positive equilibrium grid potential is dependent upon the divider action of the resistance through which it returns to B+, and the variable diode resistance which exists between grid and cathode. The total current through the 10-megohm path to B+ is virtually constant at all times; therefore,

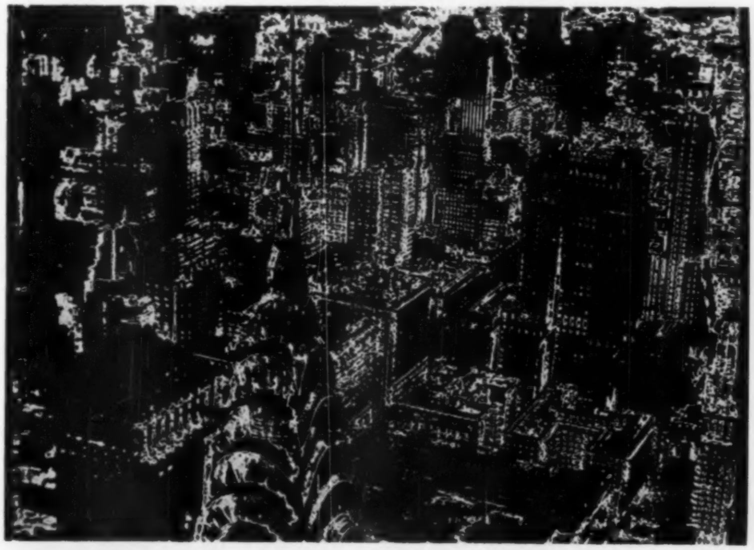


Fig. 1. Electronically processed photographic rendition of skyscraper scene.

A contribution submitted in final form on November 21, 1960, by R. L. Hallows, RCA Laboratories, Princeton, N.J.

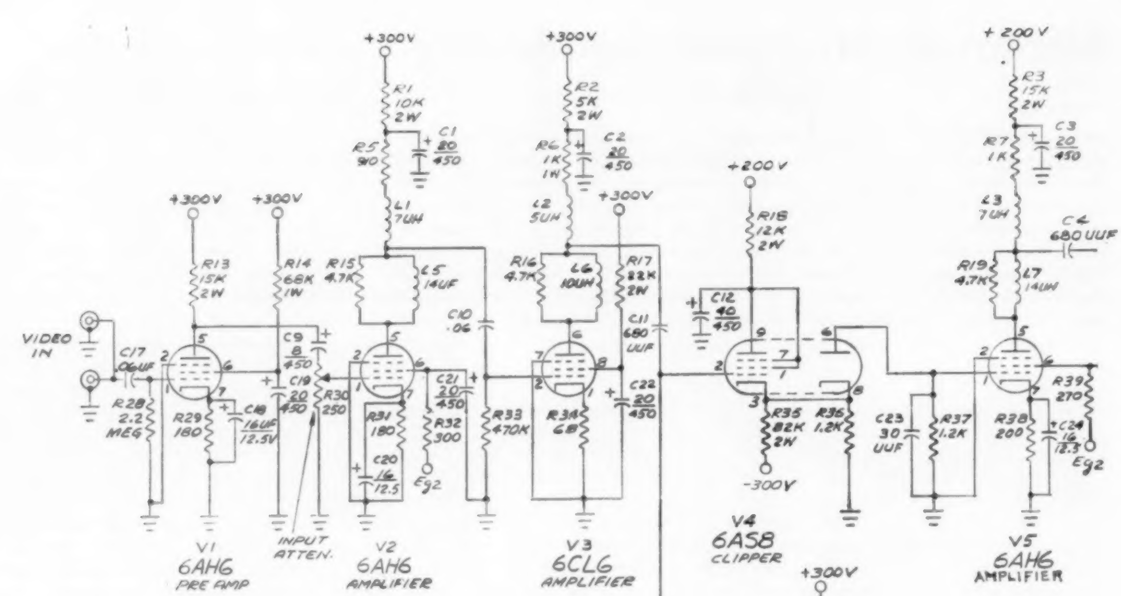
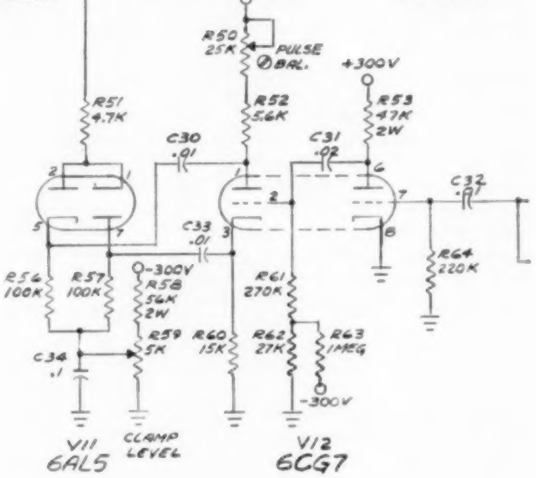


Fig. 2. Schematic diagram of outliner.



displacement current modulation through the 680-$\mu\mu$f coupling capacitor from the relatively low-impedance driving source can produce changes in the grid potential. These changes are made most easily in the direction of negative grid swing because the diode formed by grid and cathode becomes less highly conductive in that direction. Thus, the applied waveform assumes an unsymmetrical disposition about the quiescent point, and its most negative-going peaks extend beyond the diminished plate current region into the normal negative-bias operating range of the tube.

Figure 4 (A) shows the outliner plate signal for the small input sine wave, top trace. The sine-wave has been folded over the reversing transfer characteristic, and the tip of the wave happens to project back to the quiescent value of plate voltage. Figure 4 (B) is the result of a relatively greater sine wave input. Note that the peak of the wave has started to clip because it has been driven beyond the normal control grid cutoff point of about six volts. Figure 4 (C) shows the result of considerable overdriving. Notice that the fold-over region of the signal now consists of relatively sharp "spikes." The associated circuitry is adjusted so that the outlining tube always receives approximately this same degree of overdriving. Because continuous adjustment is provided to select the portion of the total video signal to be outlined, it is irrelevant at what precise level the fold-over occurs on the sine waves shown here for illustration.

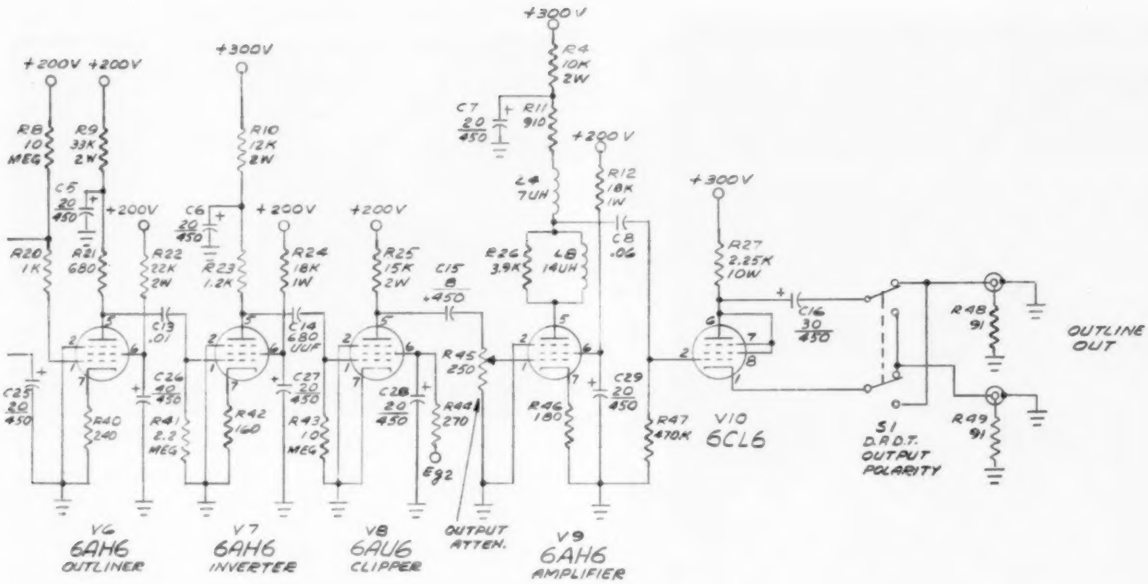
The general waveform of Fig. 4 (C) was observed over a frequency range from about 200 cps to over 300 kc. It is again apparent that no dynatron, oscillatory or other negative-resistance effects account for the sharp fold-over. The spikes are formed by projecting the input signal over a virtually static transfer characteristic which contains a reversal of slope. Their steepness is the result of presenting only a small portion of the fold-over signal as the outline signal, by virtue of the high amplification and clipping techniques to be described.

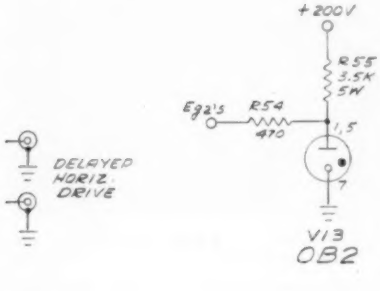
Because of the static nature of the spike-producing mechanism, there will be a discrete narrow range of video voltage which will produce the rising and falling fold-over output voltage. The probability of obtaining an outline signal along a horizontal line is increased by providing a television system with a relatively high number of scanning lines, or conversely, by providing relatively small brightness increments in adjacent lines by defocusing the pick-up device.

Tube Requirements

Relatively few 6AH6 pentodes, most of which were apparently within manufacturers' production tolerances but on the low side of optimum, functioned properly in the outliner circuit. Tubes having somewhat low transconductance or screen current caused inadequate fold-over of the video signal for clipping outline spikes without streaking. Nonetheless, all tubes which met or exceeded published g_m or Ic_2 ratings under normal test conditions (E_{bb} = 300 v; Ec_2 = 150 v; R_k = 160Ω) performed satisfactorily under the unusual outliner circuit conditions.

One exception was explainable by the presence of 0.1-μamp control grid current under normal test conditions. The gassy condition indicated probably caused the tube to draw greater than normal space current under grid-current clamp operation.





NOTE:
1. RESISTANCE VALUES ARE IN OHMS EXCEPT AS NOTED.
2. CAPACITANCE VALUES LESS THAN 1.0 ARE IN UF AND 1.0 AND ABOVE ARE IN UUF EXCEPT AS INDICATED.

It is important that the clipper tube following the outliner and inverter stages have very low control-grid current to prevent objectionable streaking. These stages will be described in the following section.

Video Circuit Functions

Standard techniques as represented in the schematic diagram are used to provide a video signal of limited amplitude, so that only the small portion of input video between the clipping levels appears at the double-clipper output. Figure 5 is an oscillogram of a gray-scale input signal with the double-clipped, or "sliced," output signal at the top. The slicing level is controlled by a keyed clamp with adjustable bias at the input to the double-clipper.

This slicing circuit, consisting of a type 6AS8 pentode-diode, is a preferred signal-limiting device for this application, because it avoids the effects of

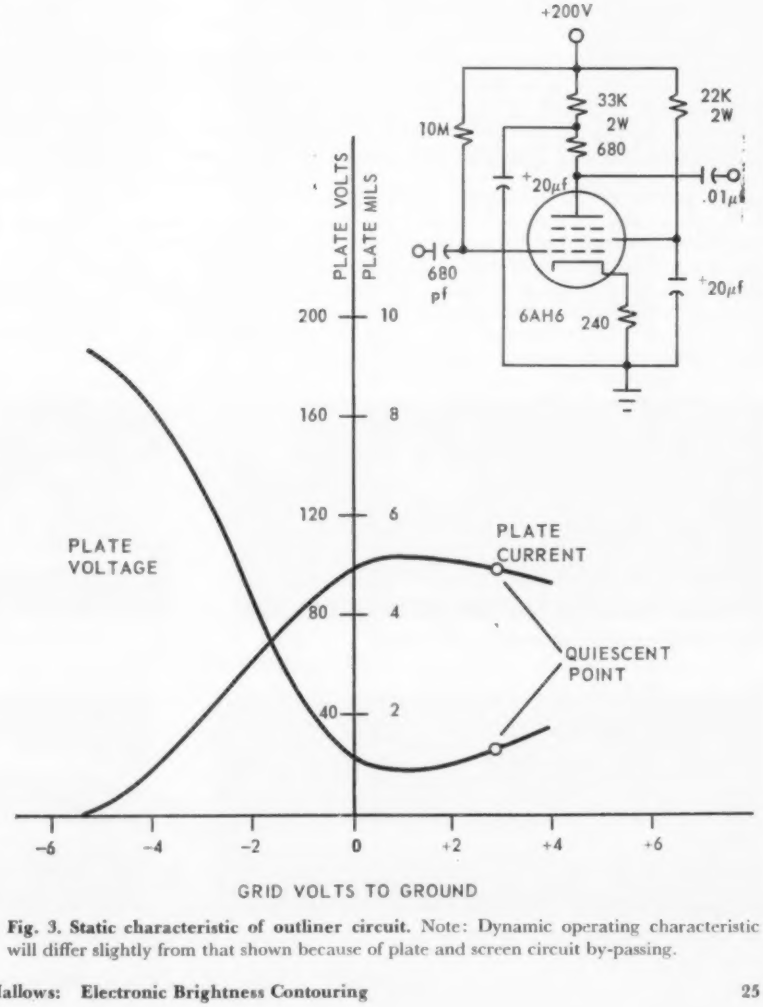


Fig. 3. Static characteristic of outliner circuit. Note: Dynamic operating characteristic will differ slightly from that shown because of plate and screen circuit by-passing.

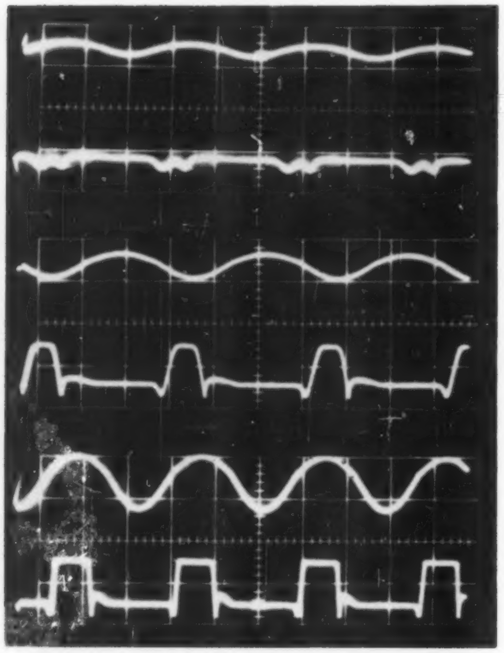


Fig. 4(A), (B), (C). Outliner plate signal for varying sine-wave input drives.

distortion which results from operation into the grid current region. The negative-going portion of the video is clipped by driving the triode-connected cathode follower beyond cutoff. This cutoff voltage was established by choosing the values of the 1200Ω load resistors at the diode input and output, and the 82kΩ bleeder resistance to the negative bias supply. The series diode biasing is such that it ceases to conduct positive-going signals before the cathode follower is driven to its grid-current point. The loading of this diode minimizes capacitive feed-through and maintains equal rise and fall times in the clipped video signal.

The two-volt slicer output is amplified by a normal amplifier, which acts as a buffer for the slicer, and a driver for the outliner.

Figure 6 is an oscillogram of the outliner plate signal derived from the step tablet video of Fig. 5. A more typical outliner plate signal is shown in Fig. 7, representing the cloud outline of Fig. 9 (B). The spikes below the base line of the trace represent the desired outline signal. It is then necessary to discard the remainder of the video signal. This is accomplished after amplification and inversion of the signal by a grid-current clamped 6AU6 clipping tube in which the peaks of the spikes are at zero-bias, and the unwanted video portion is driven beyond cutoff. The clipper plate signal, which comprises the outline, may be seen in the bottom trace of Fig. 8.

The outline signal is controlled in output amplitude and polarity, and added to the delay-equalized input video signal (top trace, Fig. 8) to produce a composite of the original image and outline. Figure 9 shows various level settings of the outliner in the black outline polarity.

Note that for very gradual changes in brightness, such as in the "toe" or "knee" portions of the cloud pictures, the contour lines break up into wide patches of grainy appearance. This limit of usefulness is inherent in the input video signal itself. That is, the brightness between the limits of area thus accentuated is actually varying in the random fashion indicated by the grain-spike structure.

To conclude, the outline signal produced by this circuit not only surpasses the performance of such well known and relatively complex pulse-shaping techniques as differentiation, inversion of negative-going peaks, and final clipping of the sliced video, but also preserves a degree of contour continuity parallel to the direction of television scan.

Acknowledgment

The encouragement of John P. Smith of the Astro-Electronic Div., Defense Electronic Products, RCA, under whose direction the concept and apparatus for this form of image processing were developed, is gratefully acknowledged.

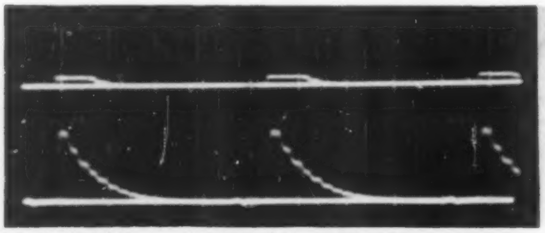


Fig. 5. Oscillogram of gray-scale input signal.

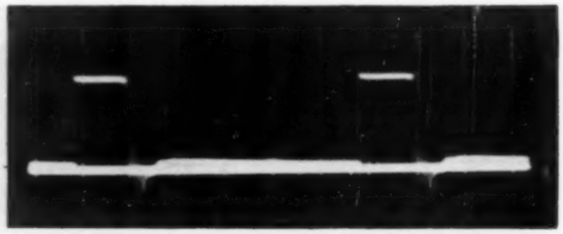


Fig. 6. Oscillogram of outliner plate signal derived from step tablet.

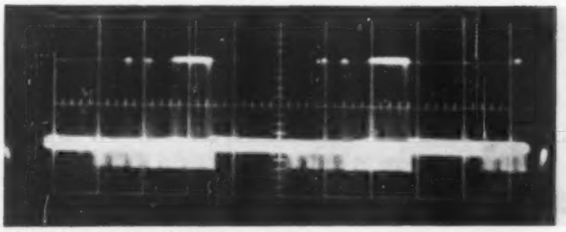


Fig. 7. Typical outliner plate signal.

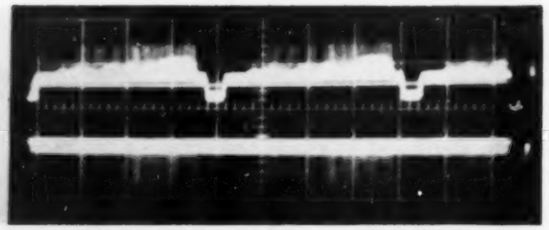
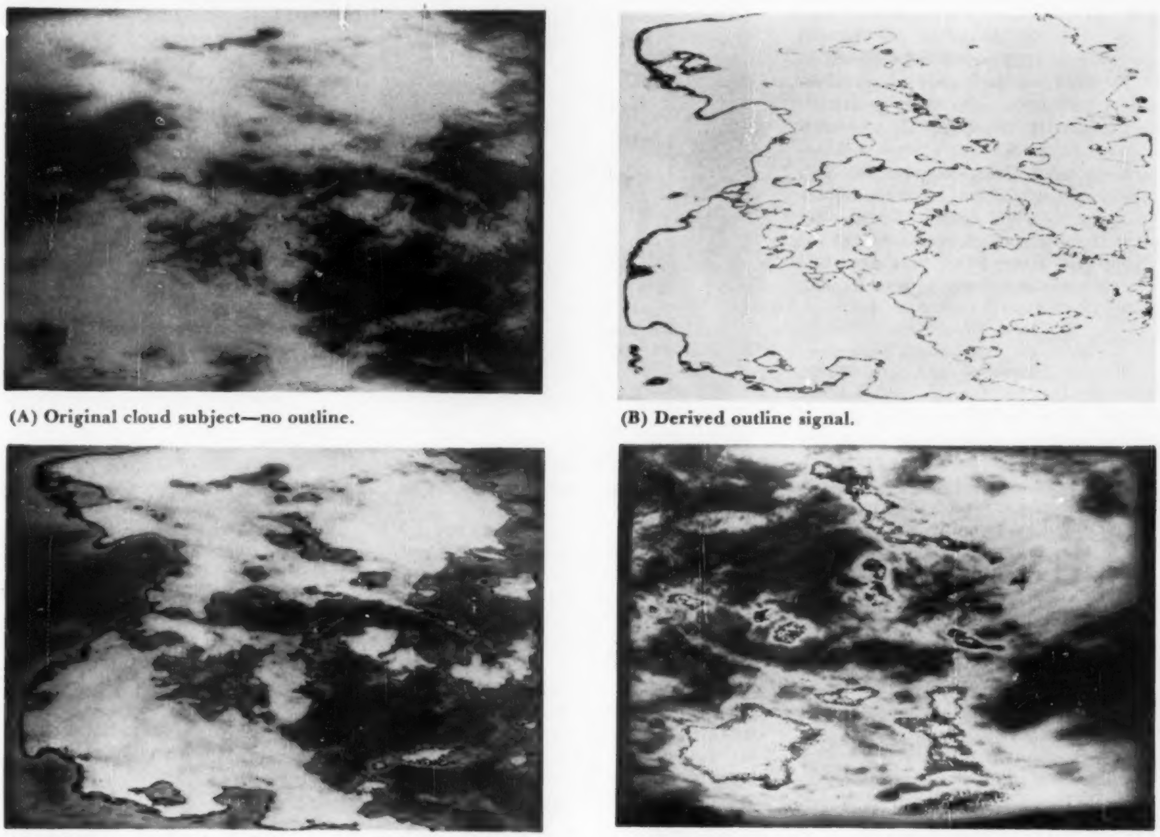


Fig. 8. Delay-equalized input video signal and clipper plate signal.

Fig. 9(A–D). Composites of original image and outline:



(A) Original cloud subject—no outline.

(B) Derived outline signal.

(C) Video superposition of cloud and derived brightness contour.

(D) Contouring further into white region of cloud.

A Television Imagery Simulator

By J. P. SMITH
and J. F. BAUMUNK

For evaluating TV Systems and for studying image enhancement techniques, there is a need for simulator equipment with adjustable and measurable parameters. Because results must be duplicated from day to day and from month to month, reliability is of importance in designing the equipment. Also, when evaluating systems of high resolution, the resolution capabilities of the evaluating means must be better than the system under evaluation. The mechanical and electrical design must be flexible so that, when new ideas present themselves, they may be developed and added to the existing equipment. A TV Imagery Simulator which fulfills these requirements has been built by the Astro-Electronic Products Division of RCA and has been in use for over two years.

THE SIMULATOR is a tool used to set up and observe the results of given TV parameters. It consists of a high-quality, high-resolution, black-and-white, TV chain with input pictures presented in the form of 35mm transparencies. A high-resolution flying-spot scanner and a multiplier phototube transform this picture into electrical signals. The signals are amplified and processed in a number of stages, and the resulting TV image is presented on a TV monitor. This imagery, which may consist of photographs of ground objects, clouds, sky objects, or of pictures taken with infrared light, ultraviolet light, or radar, may be observed directly or photographed for remote study. The equipment is shown in Fig. 1.

This simulator was useful during the early design stages of the Tiros I Satellite in determining the area of cloud cover to be scanned and in choosing the shutter speed of the TV cameras. Before the Tiros launch, it served as a source of signals having the proper parameters for testing the ground station equipment. Pictures from the orbiting satellite will be studied on the simulator to see how enhancement techniques may help meteorologists interpret them.

A contribution submitted in final form on November 21, 1960, by J. P. Smith and J. F. Baumunk, Astro-Electronics Div., Defense Electronic Products, RCA, Princeton, N.J.

Design Features

As results must be duplicated from day to day and from month to month, reliability of the equipment is of particular importance. When evaluating systems of high resolution, the resolution capabilities of the evaluating means must be better than the system under evaluation. Finally, the mechanical and electrical design must be flexible so that when new techniques present themselves, they may be developed and added to the existing equipment.

The simulator can vary parameters in a very wide range. Thus, referring to the

sync generator, block 1, Fig. 2, it is possible to vary both the horizontal sync pulses from 30,720 cps to 240 cps and the vertical sync pulses from 60/sec to 1 in 4.266 sec in binary steps. Noninterlaced frequencies are generated, but interlacing is accomplished by adding a square wave of current of one-half the vertical scanning rate to both the flying-spot scanner and monitor yokes in phase, blocks 2 and 4. The monitor may be interlaced independently of the flying-spot scanner to minimize line structure without changing resolution.

Scanning Rates

Vertical scanning rates selected by switches are 60, 30, 15, and 7.5/sec. Based on a vertical scanning rate of 60/sec, interlaced, horizontal rates may be changed by means of switches which also maintain the picture geometry. The number of scanning lines resulting, which may be selected by switches, are: 1024, 512, 256 and 128. Subtracting the lines lost in the vertical blanking interval, the useful line numbers are: 960, 480, 240 and 120. Line numbers between these values may be obtained by over-scanning the 35mm transparency uniformly in both directions or by optical reduction of the image on the transparency.

If more than 1024 scanning lines are required, the vertical rate may be reduced. Thus, if a vertical rate of 30/sec, interlaced, is used, the horizontal rate remaining the same, the number of lines is doubled to 2048. If interlacing is not desired a vertical rate of 15 may be used, making available 2048 straight scanned lines for this horizontal rate. The horizontal resolution can be increased further by reducing the horizontal rate. The limit of resolution depends on the spot and phosphor characteristics of the kinescope used in the flying-spot scanner. Kinescopes of the type used in the simulator have a TV limiting resolution of 1300 lines in the center, with an ultor voltage of 30 kv and ultor current of 25 ma. The monitor kinescope used is more than twice as good and has not been a limiting factor in the system thus far.

As the number of scanning lines is changed, the horizontal and vertical resolutions may be made equal by plugging in the proper filter and phase corrector, block 11, Fig. 2. Without the

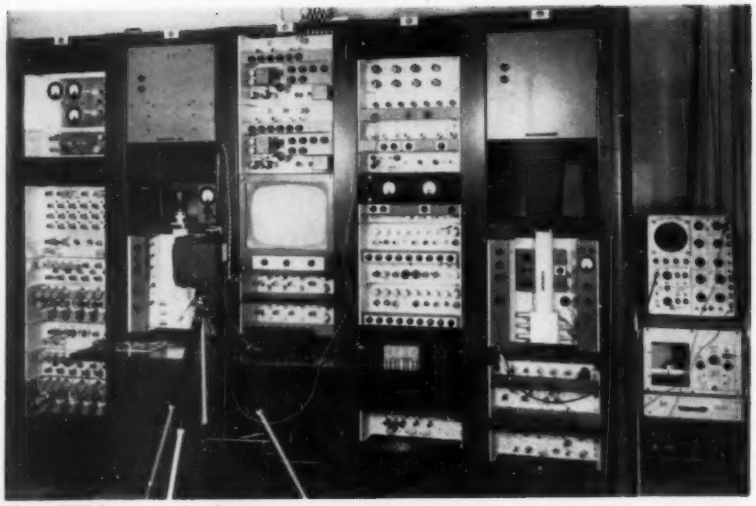


Fig. 1. TV imagery simulator.

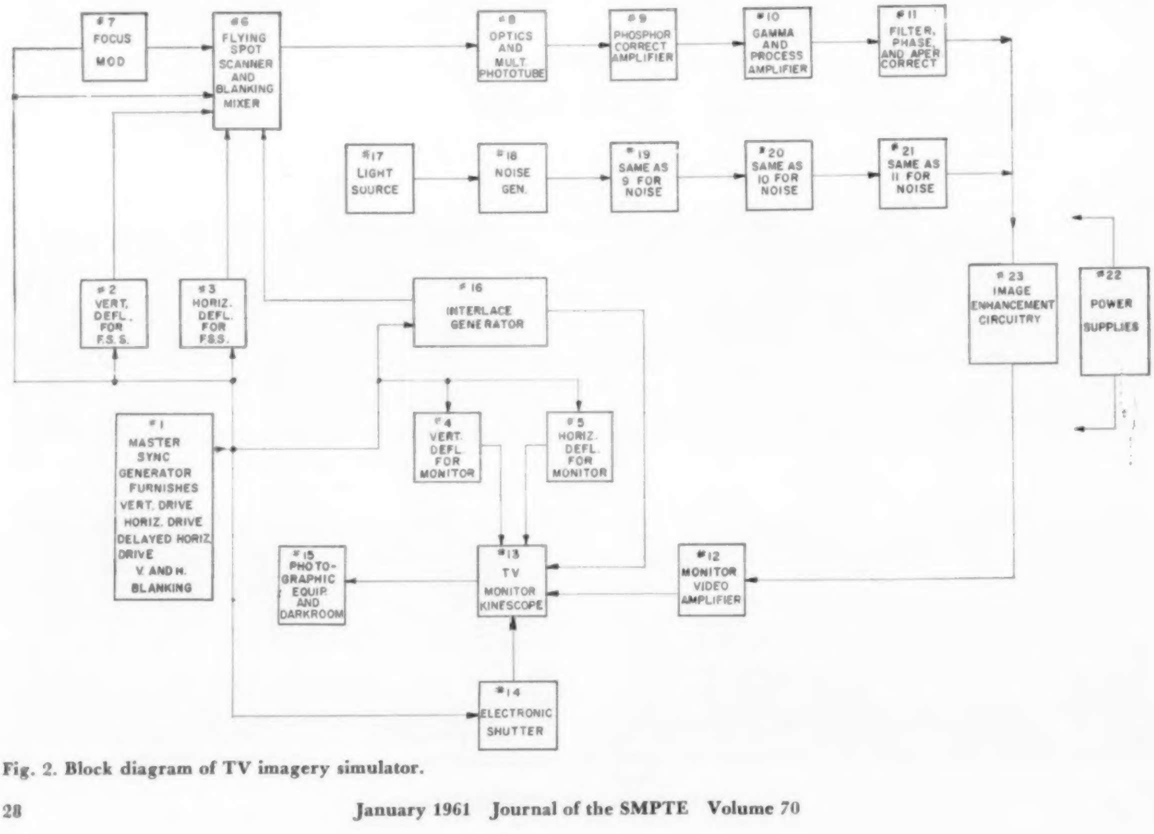


Fig. 2. Block diagram of TV imagery simulator.

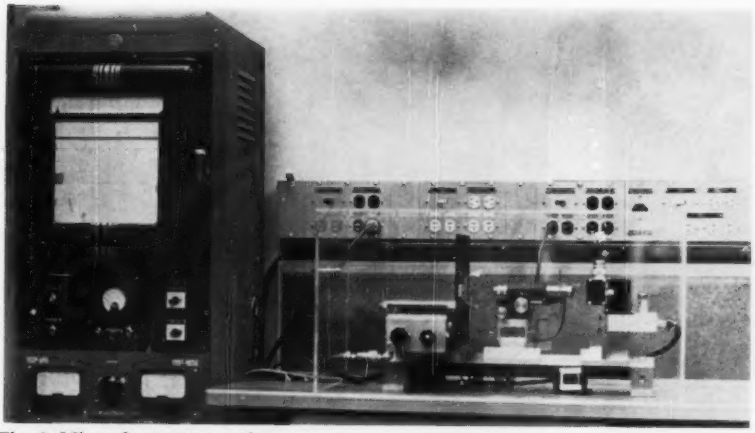


Fig. 3. Microphotometer equipment.

band limiting filters -the overall system is flat to 18 mc and down 6 db at 25 mc. This bandwidth and an aspect ratio of 3 by 4 give a limiting resolution of 740 TV lines in both directions for the highest horizontal rate generated, 30,720 scans/sec, at a vertical rate of 60 scans/sec, interlaced.

Noise Generation

As may also be seen in Fig. 2, a separate video channel is used for noise generation and for mixing with the video signals. "Flat" or "peaked" noise may be mixed with the video signals and the ratio measured. Signal-to-noise ratio is considered here as the ratio of one-half the peak-to-peak video signal to the rms value of the noise, measured separately. The signal-to-noise ratio in the photographic print is equal to this ratio divided by the gamma of the system between the point of noise insertion and the print. It is dependent, also, upon the number of frames exposed photographically, improving as the square root of the increased-exposure factor. Thus, if the exposure time is increased by a factor of 2, the signal-to-noise ratio will improve by $\sqrt{2}$, or 3 db.

For controlling the signal-to-noise ratio in the print and for insuring that one complete field or frame, or a whole number of fields or frames, is exposed on the film, an electronic shutter is used, block 14, Fig. 2. Binary counters are triggered from the vertical drive pulses to blank the monitor kinescope except for 1, 2, 4 or 8 vertical scans. The number of scans may be pre-selected and the camera shutter contacts used to actuate the electronic shutter.

Additional Equipment

Photographic equipment, block 15, Fig. 2 is at present a Burke and James 4 × 5 Speed Press camera with a Wollensak 210mm, $f/4.5$ lens, in an Alphax shutter. For making 35mm slides and for close-up work an Exacta VX with a 50mm Schneider Xenon, $f/1.9$ lens is used.

The remainder of the blocks in Fig. 2, with the exception of block 23, will not be described in detail as they contain circuitry common to the television art. Block 23, covering the image enhancement circuitry, will be described later.

At the right of Fig. 1 is a picture generator for low-speed scanning rates with an extended bellows over the lens to keep out stray light. It also uses a flying-spot scanner with 35mm slides as input information. The scanning rates brought out on switches are: vertical, 0.9375 and 0.46875 scans/sec; horizontal, 480 and 240/sec.

The bandwidth of the video amplifiers may also be controlled with filters. The numbers of scanning lines available on switches are 256, 512 and 1024. No monitor is provided except for the Tektronix 545 Oscilloscope, the signals being used for testing other equipment where pictures may be viewed.

The measurement of the transmission characteristics of a complete TV chain is a fairly complex process. To supplement the simulator and to perform this testing and calibrating function a microphotometer is needed. With this facility, transparencies or opaques taken from the TV monitor may be scanned and plotted on a recorder. By using a number of test slides, the microphotometer and its associated equipment will provide information for calculating the effective line number, or N_e, of the complete system. It will also measure the signal-to-noise ratio in a print or transparency as a check on the simulator calibration. And, it permits a more complete specification of parameters for the TV system being simulated. Figure 3 shows the microphotometer, recorder, and power supplies.

Applications to TV Systems Evaluation

The most important use of the simulator up to the present time has been in TV systems evaluation studies, although interest in the image enhancement field is increasing. In some cases the two are interrelated and should be so described. For example: one may desire to know how much noise may be tolerated before enhancement; or, if enhancement is used, what maximum bandwidth is tolerable before noise becomes objectionable. These questions have a bearing on the feasibility of adding enhancement circuity in a satellite before radio transmission. In this report these factors will be considered separately insofar as is possible.

Imagery prepared by the simulator has been used in several experiments[1] in which experienced photo-interpreters extracted meaningful information under controlled conditions. The evaluations of the various imagery were then based on the extracted information. It is interesting to note that the quality and quantity of information extracted by the photo-interpreters are not always in a one-to-one correspondence with the appearance of the imagery as perceived by the layman. Some examples of the imagery are given in the illustrations.

Figure 4 shows aerial photographs of a rural area, 2.51 by 3.05 miles. Figure 4(A) was taken with the simulator adjusted for 960 useful lines, 18-mc bandwidth, and 27-db signal-to-noise ratio, which is normal for this bandwidth. Resolution is 13.75 ft/line. Figure 4(B) shows the same picture with a signal-to-noise ratio of 15 db, obtained by adding additional noise.

In Fig. 4(C), the simulator was adjusted for 480 useful lines. A band limiting filter and phase corrector were added to maintain equal vertical and horizontal resolutions, and no noise was added. Here the signal-to-noise ratio is 30 db and the resolution is 27.5 ft/line. Figure 4(D) shows the same picture with 15 db signal-to-noise ratio.

In Fig. 4(E), the simulator was adjusted for 240 useful lines. A band limiting filter and phase corrector were added to maintain equal vertical and horizontal resolutions, and no noise was added. Here the signal-to-noise ratio is 33 db and the resolution 55 ft/line. Figure 4(F) shows the same picture with 15 db signal-to-noise ratio.

Image Enhancement Capabilities

In addition to the flexibility of standard television parameter control, facilities for special treatment of the video signal have been provided in the simulator for evaluation. These effects, or "image enhancing" techniques, may be of value in image interpretation and information extraction since pertinent features of the pictorial input can be emphasized while de-emphasizing those which are not significant.

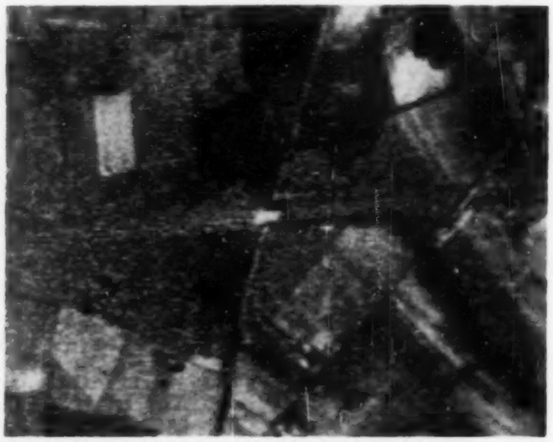
Slicing

The effect of contrast sketch or video "slicing" is one of providing increased contrast in a desired portion of the gray-

(A) 960 lines, 27db.s:n, 13.75 ft/line in both directions.

(B) 960 lines, 15 db s:n, 13.75 ft/line in both directions.

(C) 480 lines, 30 db s:n, 27.5 ft/line in both directions, band-limiting filter and phase corrector added to maintain equal vertical and horizontal resolution.



(D) 480 lines, 15 db s:n, 27.5 ft/line in both directions, band-limiting filter and phase corrector added to maintain equal vertical and horizontal resolution.

(E) 240 lines, 33 db s:n, 55 ft/line in both directions, band-limiting filter and phase corrector added to maintain equal vertical and horizontal resolution.

(F) 240 lines, 15 db s:n, 55 ft/line in both directions, band-limiting filter and phase corrector added to maintain equal vertical and horizontal resolution.

Fig. 4(A-F). Aerial photographs of a section of rural area presented on the simulator with varying TV parameters. Halftone printing reproduction of these makes some of their varying characteristics less distinguishable than they are on the simulator. Note strip through center, a turnpike, for comparison of effects of varied parameters.

Fig. 5(A-E). Contrast stretch or "slicing" and simulated two-level quantization:

(A) Original Copy.

scale transfer characteristic.[2] It is an extension of the philosophy of gamma* correction which provides greater gain in a certain portion of the video signal by controlled nonlinearity of amplification. The resulting increase in contrast renders certain details more vividly. The concept of gamma correction is usually limited to compensation for the nonlinear drive characteristics of the viewing kinescope. Slicing allows the gamma of the already-corrected signal to be increased about any desired gray-level, from black to white, to emphasize the difference between nearly-alike gray areas. Limits of useability are imposed, however, by granularity of the input picture and electrical system noise.

---

* Gamma may be defined as the ratio of the log of the subject incremental brightness to the log of the corresponding incremental image brightness. It is equal, in a general imaging system, to the slope of the transfer characteristic plotted logarithmically.

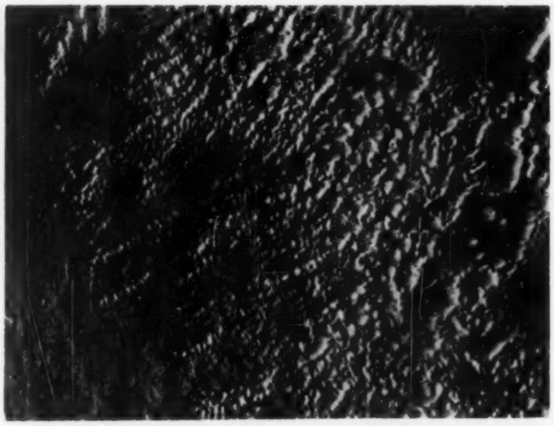
(B) 5 to 1 black stretch.

(C) 5 to 1 white stretch.

(D) 960 lines, 27 db s:n original copy.

(E) 960-line two-level quantization and outlining.

Fig. 6. Differentiation. (A) Cumulus cloud streets, 960 lines and;



(B) Cumulus cloud streets differentiated, 960 lines

The slicer circuitry is essentially a double-clipper which passes only a small portion (about 10%) of its maximum signal input. The signal portion lying between the clipping levels is controlled by a variably-biased clamp, thus providing for "slice position" adjustment. The slice "thickness" is controlled by adjustment of the input signal amplitude to the double-clipper, so that a thinner slice of the total video signal is passed when the input amplitude is increased.

The photos of Figs. 5(A) to (C) inclusive, represent an intermediate slice thickness of approximately one-fifth the peak-to-peak input level. They have been reproduced with none of the original signal superimposed, and at full contrast.

Outlining

A circuit has been developed for producing an outline, or contour of constant intensity and of either polarity, along the loci of a selected video gray-level.[3] This circuit has the ability to convert into sharp pulses of fixed amplitude, variations, or edge transitions lying between the pass limits of the slicer circuitry. If video slicing is used and presented with full amplitude in the absence of normal video, a condition approaching two-level quantization is obtained [Figs. 5(D) and (E)].

Differentiation

The interesting bas-relief rendition of the cloud streets of Figures 6(A) and 6(B) is achieved by the simple expedient of providing a short R-C time-constant of differentiation as a coupling network in the video amplifier. This provides practically no response at low frequencies, and increasing response to the higher frequencies which correspond to steeper transitions.

This technique is akin to the well-known television technique of aperture compensation in which the normally flat video amplitude response is peaked, or made to rise from beyond the mid-frequency range, but with a linear phase characteristic. The non-linear phase function of a simple differentiation network causes the three dimensional light-and-shadow effect.

Conclusions

The TV Imagery Simulator developed at the Astro-Electronic Products Division of RCA has been demonstrated to be a flexible research tool for evaluating TV systems and for studying the effects of image enhancement. TV parameters may be varied to simulate most existing TV systems; signal-to-noise ratio may be adjusted and measured. Contrast stretch, or slicing, a form of visual pre-emphasis, is an enhancement technique useful in object recognition when used before noise is encountered. Constant brightness contouring or outlining, is useful in showing up lines or areas of equal brightness quickly. Differentiation may be useful in synoptic observations. Due to its mechanical and electrical design, the simulator may be adapted for studying other television problems.

Acknowledgments

The able assistance of R. L. Hallows, G. Beck, E. Hutto, A. Pantuso, A. Pilipchuk, and G. McGunnigle is greatly appreciated. Much of the ground work for this simulator is due to Dr. O. H. Schade. The simulator work was done under the direction of J. Lehmann, Manager, Data Handling and Ground Stations, Astro Electronics Division, Defense Electronic Products, RCA, Princeton, N.J.

References

1. "An exploratory image-interpretation experiment," Part 1 (June, 1958) Part 2 (November, 1958) performed under contract DA 36-054-ORD-2677 for ABMA, Huntsville, Ala., by Astro-Electronics Div., RCA, Princeton, N.J.
2. "A study of high definition television techniques," Vol. II, May 1954, performed under contract DA-36-039-sc56653 for U.S. Army Signal Corps, Fort Monmouth, N.J. by Defense Electronic Products Div., RCA, Camden, N.J.
3. R. L. Hallows, "Electronic brightness contouring," *SMPTE, 69:* 23–27, Jan. 1961.

Recent Applications of Acoustical Engineering Principles in Studios and Review Rooms

By WILLIAM B. SNOW

The design of the interior surface of a studio or review room for acoustical control is partly a matter of science and partly the exercise of an art. A specified reverberation characteristic can be obtained with fair accuracy, but other problems are solved mainly by judgment. Several examples will be discussed where it was attempted to maintain as high a ratio of engineering to rule-of-thumb as possible.

THIS PAPER was written primarily to show the results of acoustical design obtained in some studios and review rooms which have been built and tested. As an introduction it appears desirable to discuss briefly the acoustical engineering principles which were applied during the design phases. In this presentation the important subject of reducing outside noise to an acceptable value is assumed to have been given adequate attention; therefore only the control of the internal acoustical conditions is discussed. Certain combinations can be made, but, on the whole, it is necessary to build a very substantial structure as the outer shell of a studio and then to construct a separate inner structure for this acoustical control.

FUNDAMENTAL PRINCIPLES

There are many details in the acoustical design, but most attention is paid to control of reverberation and to promoting sound diffusion. Much of the art of the design represents the struggle to combine pleasing appearance, and practical working shape and surfaces, with the requirements for acoustics.

Sound Diffusion

By diffusion, we mean arranging the bounding surfaces in such a way that sound is rapidly reflected into all parts of the room with relative uniformity. This is usually accomplished by giving the walls a rough outline with angles, convex cylindrical columns or portions of spheres, and alternating patches of absorbent and reflective materials. There have been numerous attempts to place diffusion control on a numerical basis, but so far such methods have not been very successful in correlating with user preference for the rooms. In general, diffusion control is done empirically on the basis of the designer's experience. Rooms in which the work has been done carefully "sound better" than rooms in which little attention has been paid to this facet of design.

Reverberation Control

Reverberation is the one acoustic property of a room that can be measured easily and controlled well. Figure 1 illustrates the buildup and decay of sound in a studio. When a steady sound is started, the sound level very rapidly builds up to that constant value at which the room surfaces absorb sound at exactly the same rate as it is emitted by the source. According to the simplified theory applicable to well-designed rooms, this sound level is the same throughout the room. This is called the reverberant sound level. When the source is stopped, the sound levels decay at a logarithmic rate which can be expressed in decibels/second. However, the historical and usual way of expressing reverberation is to speak of reverberation time, which is the time required for the sound to decay 60 db. In Fig. 1, for example, the sound is decaying at the rate of 75 db/sec, which means that it will decay 60 db at 0.8 sec. The reverberation time is therefore 0.8 sec.

Reverberation control means controlling this rate of sound decay. When good sound diffusion has been secured, the decay rate will be relatively smooth and of uniform slope as shown by the solid line of Fig. 2. In the case represented by the dotted line, poor reverberation control combined with poor diffusion has resulted in a rough curve which decays at one slope throughout part of the range, and at a much slower rate in the following portion. These effects can be heard in the room and are usually described qualitatively as giving a "rough" character to the sound.

Many people consider that reverberation control consists of merely nailing up acoustical tile wherever it is convenient, usually on the ceiling, hanging up a few drapes, or installing wall-to-wall carpeting. For rooms where acoustical conditions are critical, this is far from the case. Figure 3 charts the absorption characteristics of the materials just described. It shows that they have very high sound absorption above 500 cps, but a rapidly falling efficiency at low frequencies. This means that rooms treated only with such materials will have long low-frequency reverberation and will sound "boomy." To obtain the proper reverberation time, it is necessary to combine materials of this sort with low-frequency absorbers. Their characteristics are also shown in Fig. 3. These are essentially acoustical resonators broadly tuned at the low frequencies. This type of structure comprises an enclosed mass of air connected to the room through properly proportioned holes or slots. As will be seen, to obtain high absorption at the lowest frequencies requires that these enclosed spaces be

Presented on May 2, 1960, at the Society's Convention in Los Angeles by William B. Snow, Space Technology Laboratories, Canoga Park Div., 8433 Fallbrook Ave. Canoga Park, Calif. The author is now at Bissett-Berman Corp., 12248 Santa Monica Blvd., Santa Monica, Calif. (This paper was received on November 25, 1960.)

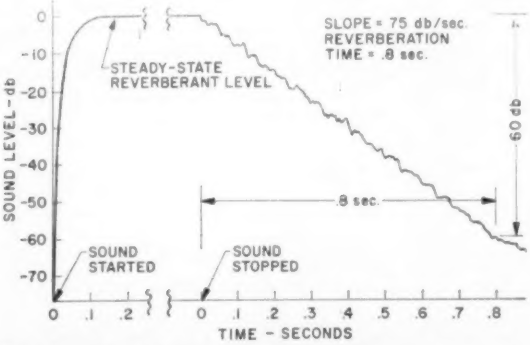


Fig. 1. Growth and decay of sound in a room.

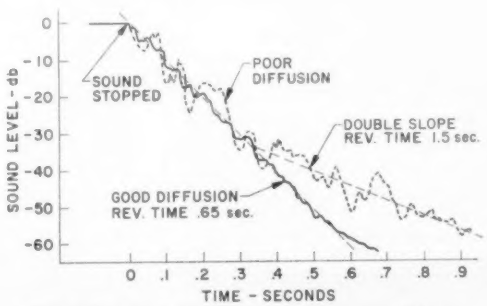


Fig. 2. Decay of sound, good and poor conditions.

effectively deep. A second principle used to obtain low-frequency absorption is damped panel resonance. The most popular material for this in the past has been thin plywood. Many of the newer acoustical tiles, properly mounted, also give the effect.

The reverberation time is controlled by the provision of a proper amount of absorption; however, it is not satisfactory to place this absorption indiscriminately. For best results, it must be distributed about the room so that sound in all parts of the volume will have equal access to it.

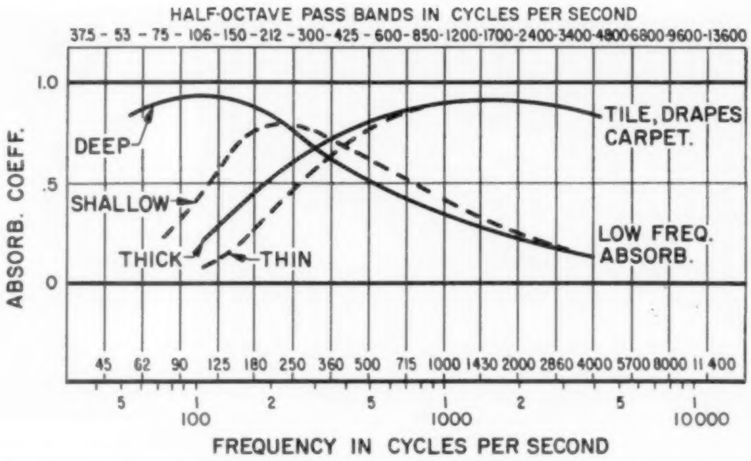


Fig. 3. Sound absorption coefficient vs. frequency. Ordinary materials have low absorption at low frequencies. Special low-frequency absorbers complement this characteristic.

SMALL STUDIO

Proceeding now to the practical applications, Fig. 4 shows a small recording studio constructed by General Motors Photographic, Detroit, which they call the Band Studio. Its dimensions were 30 × 20 × 11 ft (6600 cu ft) before the acoustical treatment was installed. The illustration shows the end opposite the control room windows that is labeled South Elevation in Fig. 5. Note the irregular outline provided by plywood panels installed in a sawtooth configuration. The plan view of Fig. 6 shows that a similar construction was used along the east and part of the west wall.

At the corners, a series of vertical lines denotes low-frequency absorbers (Det. 18) which were installed in these locations because corner space is of minimum use, yet is particularly effective acoustically. These absorbers are described in detail later.

The ceiling treatment consists principally of a shallow convex V of plaster board to which acoustical tile was applied in patches for final "trim" of the high-frequency reverberation time. It was necessary to run an air-conditioning duct through the room as shown in the upper part of Fig. 6 The area between the duct and the wall was made into

Fig. 4. Small Band Studio, General Motors Photographic.

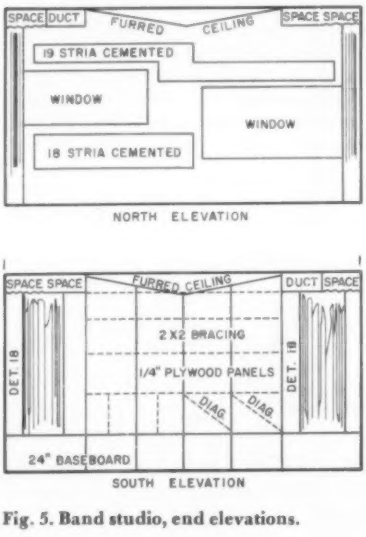


Fig. 5. Band studio, end elevations.

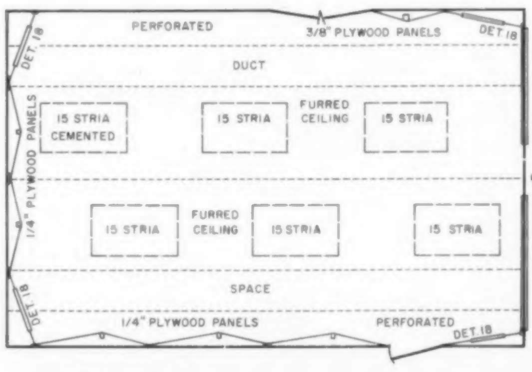


Fig. 6. Band Studio. Solid lines give plan view. Dotted lines give reflected ceiling plan.

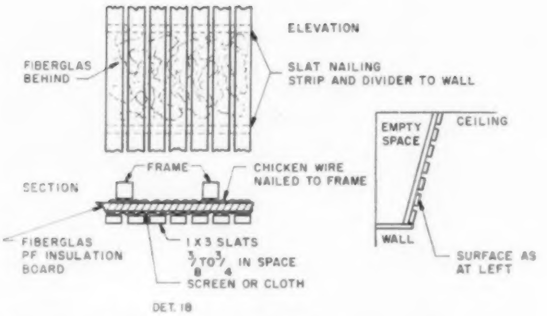


Fig. 7. Details of low-frequency absorber constructions.

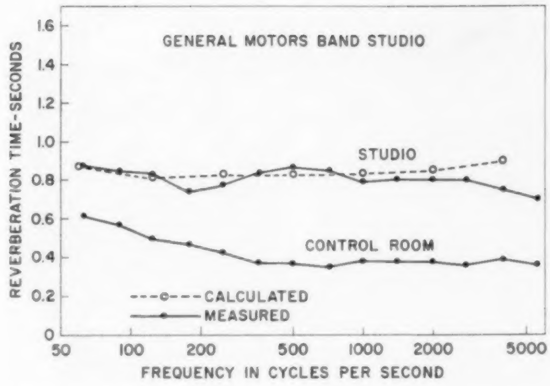


Fig. 8. Reverberation time vs. frequency in the Band Studio.

a low-frequency-absorber air space by installing perforated Transite material from the bottom of the duct to the wall and placing an acoustical blanket on top of the perforated panels. For balanced appearance the same area of perforated panel was installed at the opposite side of the room with a dummy duct. Here, the enclosed space was larger and the low-frequency peak was at a lower frequency.

Low-Frequency Absorber

A detail of the low-frequency absorber used in this studio appears in Fig. 7. It is patterned after a design by R. W. Leonard and L. W. Sepmeyer.

The absorber consists of a series of 1×3 wooden slats which are nailed to a supporting frame with $\frac{3}{8}$- to $\frac{3}{4}$-in. spaces between slats. Behind the slats is a layer of Fiberglas PF acoustical board. Between the board and the wall is the empty air space mentioned above. The wire behind the acoustical board is added for strength; the screen or cloth behind the slats for appearance. Neither is needed for acoustical purposes. In an electrical analogy of this resonator, the empty space represents a capacitance, the mass of air in the spaces between slats represents an inductance, and the acoustical board represents resistance to control the width of the peak. In other small studios at the General Motors' installation the slat treatment was applied, as shown at the right in Fig. 7, to the ordinarily empty space at the top of walls so that no floor space would be taken up by the low-frequency absorbers.

Results

Diffusion is good in this room and the sound has a "pleasant quality." Figure 8 shows the reverberation time characteristic of the completed studio (solid line) compared with the design curve (dotted line). It is substantially uniform as a function of frequency and follows the anticipated relation fairly closely. The reverberation times shown in this and other illustrations were measured using $\frac{1}{2}$-octave bands of thermal noise centered at the frequency where points are plotted.

It may be of interest to describe the way in which these curves were made. When the acoustical construction was completed, the author prepared a magnetic tape containing the noise band signals with proper timing and mailed this to General Motors. At the studio the tape was reproduced on one recorder, while the sound decays were recorded on a second machine. The resulting tape was mailed back to the author who then measured the decay rates on a level recorder in Santa Monica. Although this studio required no alteration after it was first constructed, another studio did require special alterations based upon measurements made in this way. The results of the alterations were checked using the same technique and were found to be satisfactory.

Control Room

Figure 8 also shows the measured reverberation time of the control room associated with this studio. Most of the reverberation control here was provided by the absorption of an acoustical tile ceiling mounted 12 in. below the structural ceiling. The control room curve illustrates the fact that acoustical materials are now becoming available which, when properly installed, give high absorption down to low audio frequencies. It was considered important that the control room reverberation time be considerably shorter than that of the studio so that monitoring would primarily depend upon the acoustical conditions in the latter. Note that the reverberation time would be much too short for a studio. This demonstrates the fact that merely covering a large portion of a studio surface with sound-absorptive tile is not the way to obtain ideal acoustics.

DUBBING/LOOPING STAGE

A different type of problem presented itself at Columbia Pictures Corp. where a new dubbing stage, known as No. 3, was built at the end of existing Sound Stage No. 2. The resulting room was 71×45 ft in area. The height was 24 ft to the roof trusses which were taken as the ceiling line. The volume was approximately 80,000 cu ft. It was desired that dubbing be carried out while shooting was in progress on the opposite side of the new separating wall; consequently, an elaborate multiple wall structure was required. From the standpoint of internal acoustics, Columbia wished to have a wide range of possible reverberation times and also to be able to use the stage for looping when necessary.

The looping requirement made it necessary to eliminate the possibility of flutter echoes and bad reflection conditions in all parts of the room. To secure a large change of reverberation time, a great deal of surface in a room must be altered from being absorbent to being nonabsorbent. The hinged panel construction shown in Figs. 9 and 10 was developed for this purpose. These panels covered most of the length of both sides of the room and were the full 24-ft ceiling height. They were made in two sections, each 12 ft high, for convenience as well as more diversity in adjustment.

Reverberation Variation

The detail of Fig. 9 shows that the panels were placed in a sawtooth arrangement which left empty spaces between them and the wall. One side of a panel was a hard surface consisting of two layers of $\frac{3}{8}$-in. plaster board nailed to the 2×4 framing of the panel. The inner side was filled with a 4-in. layer of glass fiber covered with cloth to give pleasing appearance. When the panels were in the "hard" positions the plaster board surfaces were exposed. The outline of the room was quite irregular because of the angular pattern. Flutter

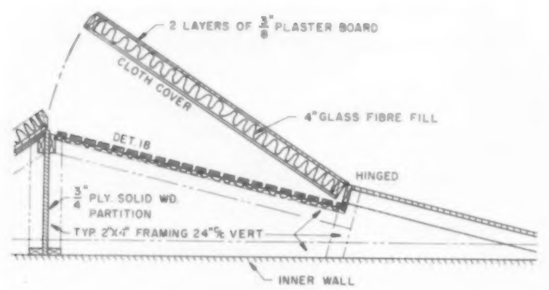


Fig. 9. Detail of hinged panel for reverberation variation. Panel closed is highly reflective. Panel open is highly absorbent at high frequencies. Uncovered Det. 18 low-frequency absorber gives uniform overall absorption for the combination.

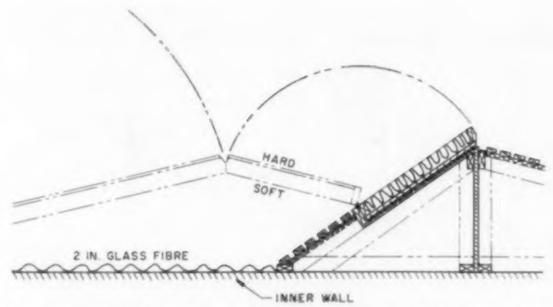


Fig. 10. Detail of panel next to that of Fig. 9. Solid lines show hinged panel in "soft" condition, exposing part low-frequency absorber and part high-frequncy absorption. Dotted lines show panel mating with following one to give all-hard surface with irregular angular outline.

echoes could not be detected. When the panels were swung to the "soft" positions the glass fiber side was exposed. This gave a great deal of absorption at the high frequencies but less relative absorption at low frequencies. The surface uncovered by swinging the panels to the soft position, for a panel such as shown in Fig. 9, consisted of a low-frequency absorber of the slat design (Fig. 7) employing the empty space behind the wall angles to provide the necessary trapped air space. Consequently, the absorption was increased over the whole frequency band with relative uniformity. Figure 10, which illustrates the panel at the left of that in Fig. 9, shows that not all spaces were treated completely with low-frequency absorbers. In some cases, glass fiber was fastened directly to the inner wall. Since the glass fiber does have appreciable low-frequency absorption, it was not necessary to furnish as many square feet of low-frequency absorption as of high. This figure also shows how the lengths of door and hinge points were worked out to give the angular outline and still allow the surface to be completely hard or completely soft.

Results

Figure 11 shows the resulting reverberation times for all panels in the hard and all panels in the soft condition. The agreement between predicted and measured results is satisfactory, and it will be seen that very nearly a constant change of reverberation time over the whole frequency range was obtained. Actually, the resonating panels were somewhat more effective at the very low frequencies than had been anticipated on the basis of the rather small amount of design data available. However, the results in this and the previous room demonstrate that this method of obtaining low-frequency absorption can be relied upon to give anticipated results. It also has great advantages in that it is relatively inexpensive, is easy to describe to construction workers so that it will be built as designed and yields an appearance which is pleasing.

Note that the total change of reverberation time obtained was almost 2 to 1 in this studio. The design demonstrates that such results can be achieved, but only when a very large amount of surface is made adjustable. While only the extremes have been shown in Fig. 10, the reverberation times varied approximately in proportion to the area of panel changed from hard to soft. It was found that the low-frequency reverberation time could be shaped up or down, without important change at the higher frequencies, by merely "cracking" open the panels which covered the low-frequency resonators.

The ceiling, as carefully designed as the wall surfaces, consisted of a wavy surface with patches of absorption, hard finished portions and low-frequency absorber portions. The final result was a room in which the sound diffusion appeared excellent. Although the room has been used mostly for dubbing, it is also a good studio for musical recording.

Mixer Listening Conditions

One of the difficulties with a dubbing stage is that it is supposed to reflect, as nearly as possible, the acoustics of a theater; yet, it is seldom possible to obtain adequate length for this purpose. The dubbing console is usually placed very close to the rear wall. This frequently results in bad standing-wave sound distortions at the ears of the mixers. Figure 12 illustrates expedients used in Dubbing Stage No. 3 to ameliorate these effects. Behind the mixers two large partial cylinders were mounted on the rear wall. These cylinders were merely

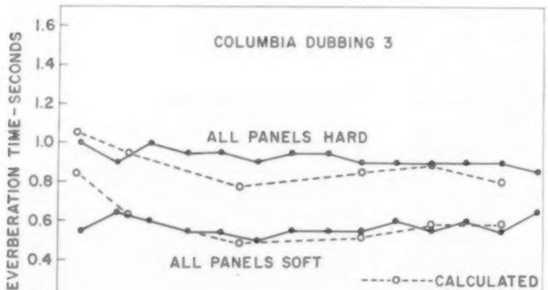


Fig. 11. Reverberation time vs. frequency, Columbia Dubbing Stage No. 3.

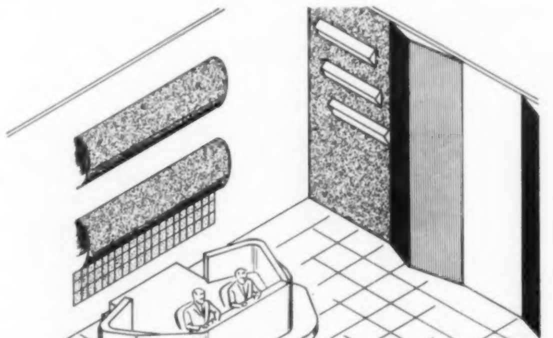


Fig. 12. Details of acoustical surroundings for mixer position, Columbia Dubbing Stage No. 3.

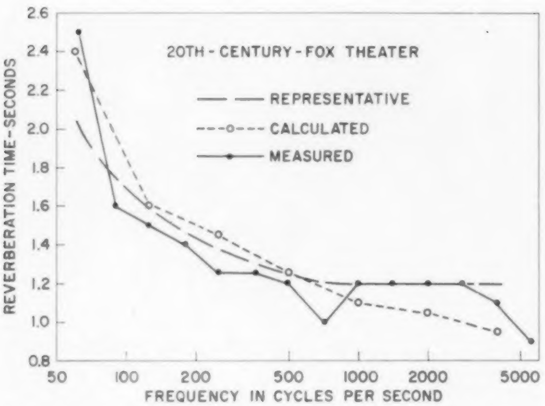


Fig. 13. Reverberation time vs. frequency, Twentieth Century-Fox Film Corp. representative theater.

Fig. 14. Belock Recording Studio.

wire mesh frames with a covering of 2-in. glass fiber absorbent and an outer sheath of cloth to add to their appearance. The purpose of the cylinders was to yield as high absorption as could be obtained over the whole frequency range, with the cylindrical shape giving diffuse reflection to any sound which was not absorbed. At both sides of the stage this end section of wall was made heavily absorbent to reduce side reflections; however three hard triangular diffusers were placed on each wall so that some diffused sound would be furnished. Above the heads of the mixers a very absorbent spot was installed in the ceiling. These techniques have resulted in good conditions at the mixing console.

REPRESENTATIVE THEATER

Twentieth-Century-Fox Film Corp. recently constructed a new sound building in Beverly Hills. This included a theater in which it was desired to match the acoustical characteristics of a "representative motion picture theater." This is an all-concrete building, 120-ft long, with sloping walls, so that the width varies from 71 to 76 ft, and a sloping floor, so that the height varies from 24 to 30 ft. The volume is 250,000 cu ft. Architectural design was worked out by the company, but the author was asked to aid in specifying the internal surfaces for acoustical control.

All the seats in the theater are heavily-padded theater chairs which add considerable absorption and make the change from empty to full audience small. To control low-frequency reverberation, the ceiling was constructed of $\frac{1}{4}$-in. plywood. On top of this, 4 in. of blown insulation added acoustical damping and thermal insulation between roof and ceiling. High-frequency absorption was obtained from complete covering of the rear wall and partial covering of the side walls with acoustical tile. Additional absorption came from heavy glass fiber treatment behind the screen, and from drapes surrounding it. Finally, to furnish some additional medium-low-frequency absorption, a wainscot was employed. It consisted of a perforated hard board facing, with $\frac{3}{16}$-in. diameter holes on 1.5-in. centers, backed by a 4-in. layer of glass fiber between the facing and the concrete wall.

Results

The reverberation time in this theater is given in Fig. 13. The dashed line indicates what was taken as representative of the class of theater being simulated. The dotted line illustrates the expected performance. The solid line shows that the final measured reverberation times came close to the anticipated results, and were even closer to the desired characteristic. This indicates that the acoustical tile did not yield quite as much absorption as was used in the calculations, probably because it was installed on a relatively small portion of the total room surface.

LARGE RECORDING STUDIO

The final studio to be described was built by the Recording Division of Belock Instrument Co., Bayside, Long Island. Figure 14 shows the outside of this structure consisting of a steel frame covered with aluminum siding. The roof was constructed of Fiberglas form board, covered by 2 in. of gypsum material and topped by the usual waterproofing roof treatment. Inside the aluminum shell, two layers of plaster board on staggered studs were installed for noise proofing. This appeared adequate for the relatively quiet location and for the recording schedules employed. The room is $77 \times 46 \times 29$ ft, with a volume of 104,000 cu ft.

The internal acoustical treatment is similar to that described for the Columbia Dubbing Stage No. 3. In this case, hinged panels were used on both sides and across one end. Figure 15 illustrates the appearance looking toward the control room. This end of the studio is flat plasterboard and the light-colored strips are layers of $\frac{3}{4}$-in. perforated acoustical tile covering one-half the surface. Tile also covers the control room face.

Figure 16 shows the opposite end of the studio. Note that the movable panels in this case extend half-way from the floor to ceiling, and have a height of 14 ft. The irregular angle pattern of panels was continued from floor to ceiling so that the diffusion would remain good in the upper part of the studio. Figure 17 is a perspective drawing of this same end of the studio. It exhibits the large permanent slat absorbers installed in the corners, the slat absorbers uncovered by hinged panels at the ends and sides, and the patches of acoustical tile placed on some upper portions of the walls to trim the high-frequency absorption.

Since the ceiling was constructed of 2-in. fiber glass material, the reverberation time would have been too short had all of this surface remained exposed; therefore, 40% of the area was covered with inverted V-slat structures which aided the low-frequency absorption and increased the reflection of high-frequency sound in a diffused manner from one end of the studio to the other. The floor was of vinyl tile installed on cement. This appears to be the most practicable floor covering for a general purpose studio. It is satisfactory provided the ceiling is given proper consideration, as in this case. If it is necessary to eliminate footfalls or floor reflections, scatter rugs can be used at appropriate places.

Results

Figure 18 gives curves of the reverberation times measured with all panels in the hard and all panels in the soft condition, compared to the design objective curves. The results are seen to be

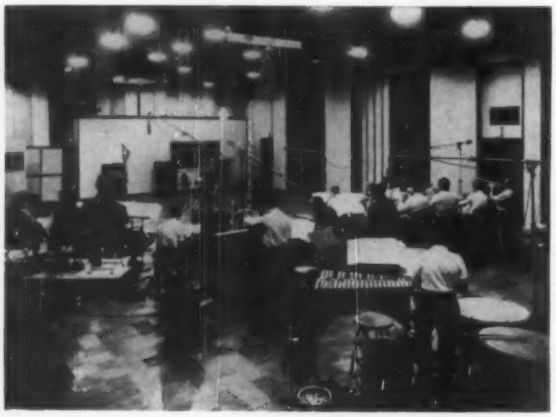


Fig. 15. Belock Studio, West wall. A panel as in Fig. 9 is shown open behind the trombone section.

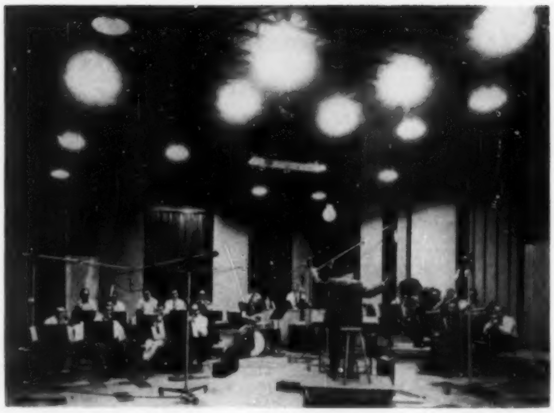


Fig. 16. Belock Studio. East wall. Inverted V low-frequency absorbers were installed over 40% of the Fiberglas ceiling surface.

in good agreement except at the very low frequencies where an even flatter curve was obtained than had been calculated. This is ascribed to the very large amount of plaster board surface mounted on long studding. There are no measured data in the literature on the absorption of such structures. For the calculations, the author used absorption coefficients which he felt were proper based upon his previous experience. However, such surfaces appear to have even greater absorption, due to panel action, than has been generally thought. If accurate information could be obtained regarding this effect, it could be employed as part of the design in studio structures.

One of the features of this studio, which has been pointed out by those using it, is that many different types of "acoustical backing" for a musical group can be secured by placing them in proper relation to the acoustical panels adjusted in various ways. These include totally reflecting conditions with good spreading of the sound, situations where all frequencies are heavily absorbed, or those where either high- or low-frequency reflections are emphasized.

Control Room

The control room for this studio had perforated acoustical tile covering most of its surfaces. A slat treatment in the upper wall corner (Fig. 7) was added to give a uniform reverberation characteristic with a reverberation time about half that of the studio. In addition, the wall behind the mixer console was treated with a 4-in. layer of glass fiber behind cloth to reduce to a minimum standing waves at the mixer's position.

CONCLUSION

In studios and review rooms, sound is so important that it should be, and frequently is, allowed to outrank other considerations. Fortunately it is possible to obtain good acoustics with known techniques, at the same time maintaining pleasant surroundings and good appearance. The methods which have been described in this paper are by no means the only ones which can be employed to obtain these effects; but they have been proven to be practical methods which will yield predictable results at reasonable cost. If an organization wishes to experiment somewhat, there are a number of other constructions which might be used to give a different look but the same acoustical surroundings.

Acknowledgments

I would like to express my sincere appreciation to General Motors Corp., Columbia Pictures Corp., Twentieth Century-Fox Film Corp., and the Belock Instrument Corp. for allowing me to use their studios as examples of design principles in this paper.

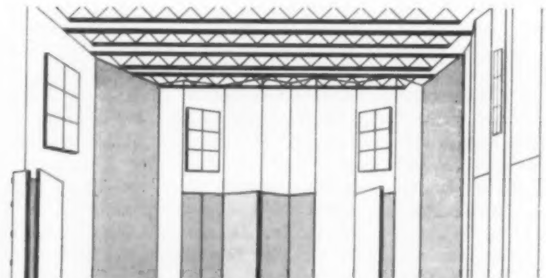


Fig. 17. Perspective sketch of Belock Studio, eastern end.

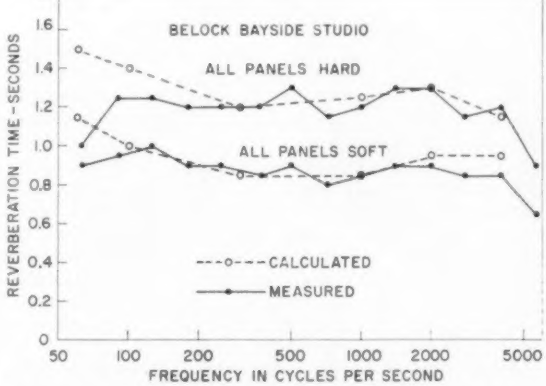


Fig. 18. Reverberation time vs. frequency, Belock Studio.

Artificial Aging of Latent Image in Ektacolor Paper

By TED H. HORN

Variations in Ektacolor process control strips indicate that a method of producing reliable strips is needed. Present process controls are examined to determine the requisites of such a method. It is found that the prime requisite is a short stabilization period. This means forced aging. Heat is selected as the aging agent. Experiments are performed to find the proper temperature and exposure time. Further experiments are made to obtain images in a near-normal balance range. Reliability of results is discussed.

Process control strips produced from Ektacolor paper have been found to be unreliable when printed in large amounts for use over an extended period of time. In addition, strip variations produced by the process to be controlled, may be mistaken for latent image changes. These inconsistencies indicate that a method of preparing stable process control strips is needed.

Currently, one of two preparation methods is generally employed in laboratories where no sensitometer is available and where a production printer is used to expose control strips.

Present Methods of Preparation

In one method, a fresh strip is printed from a standard negative as the control cycle demands. It is then developed immediately.

One drawback in this method is the inherent drift of printer circuits and the attendant printer balance shift. Consequently, the analyst can never ascertain whether strip variations noted during the control cycle should be attributed to the process or to printer drift.

The alternative method is more promising. Depending upon the laboratory requirements, as much as a full roll of paper is exposed to the control patch. After an aging period, it is divided into small lengths for process control strips.

During the comparatively short time required to expose one roll of paper, the printer drift is small. Furthermore, its magnitude can be easily determined by sampling the exposed roll at various intervals, developing the samples simultaneously, and then comparing them. The aging period, however, can lead to difficulties.

The manufacturers suggest that the latent image be aged at room temperature from 48 to 72 hr. After that, they maintain that a level of stability is achieved which will safeguard against balance shift if the control strips are subsequently stored at approximately 0 F.

A contribution submitted on August 22, 1960, by Ted H. Horn, B & H Photo, Division of Perfect Photo, Inc., 3030 South Boulevard, Charlotte, N. C.

In practical application, however, storage at 0 F may either be impractical or impossible. Moreover, control errors caused by strips thawed insufficiently before development can be disastrous.

A careful tabulation of long range latent image behavior shows that strips stored at 32 F are reasonably stable within one week after the manufacturer's suggested 72-hr aging period. Between five and seven days after crossing over to a new batch of control strips, a balance shift equal to 0.10 density, to yellow-red, is experienced.

Re-zeroing the standards, at this point, is of only temporary value since seven days later, an additional spread averaging approximately 0.05 reflected diffuse density occurs in the same direction. And again, for the following seven days, an increase of another five points can be noticed.

Such conditions make stable process control nearly impossible. The analyst never can be sure whether a major deviation from the norm is due to latent image change, or to a physical or chemical misalignment of the process itself.

Long-Term Aging

A latent image of useful stability can be achieved by aging the exposed strips for 21 days before refrigeration. After this treatment, stability has been found to be excellent. Variations between samples at the beginning of a 250-ft roll, and those made at the end are well within the accuracy and reliability limits of most densitometers when the roll is used at the rate of three to four three-foot strips per day.*

Although this method of preparing reliable process control strips renders satisfactory results, it is rather cumbersome. A surplus equivalent to the control needs for three weeks' testing (to cover the aging period) must be kept on hand at all times. This means that frequently the emulsion of the strips used may differ from that being employed in production. While behavior patterns for any given process variation generally move along parallel lines for various emulsions, frequently the magnitude of deviation varies from group to group. On some occasions dissimilar behavior was recorded.

* Averages of readings taken from at least three patches per strip are used for this comparison.

Another disadvantage of long-term aging is the severe balance shift which occurs in the control patch. It can be argued that the absolute balance of the patch is of minor importance since process control primarily operates with comparative values. It must be pointed out, however, that a patch showing a near neutral balance will already permit visual recognition of gross aberrations. This may protect the production department from remaking hundreds of customers prints.

A large spread in the color balance of the patch makes accurate evaluation in the darker areas difficult. Either the yellow or cyan layers, or both, will render densities so high that the reliability of those readings must be questioned.

To summarize, an Ektacolor process control strip should exhibit the following properties in order to be of maximum value to the analyst.

(1) Cold storage requirements should be no more severe than those for overnight storage of production material.

(2) The latent image must be stable for a period of time long enough to use up a reasonable amount of pre-exposed strips, but for no shorter than three weeks.

(3) Stabilization periods must be short so that the emulsion used for process control may be representative of that used in production.

(4) The final balance of the strip must be close to normal, and the density must facilitate reliable and useful readings.

Artificial Aging

It is evident that the main problem confronting the control man is to achieve as short a stabilization period as is possible without sacrificing reliability. The remaining three requirements can then be realized with comparative ease.

Shortening the stabilization period means forced aging. Primary considerations are how easily this can be accomplished and how well the final results satisfy the required conditions.

Elevated temperature is known to effect rapid changes in the latent image. Since moderate heating is easily produced, this line of approach to aging was thoroughly investigated in the analytical section of Albern Color Research, Inc.

Using an Eastman Kodak 4 C Printer, a number of identical exposures were made from an Eastman Kodak Test

Negative, slope series #4, indoor, on the normal button. The exposures were cut into groups of four. For ten minutes, each group was subjected to various degrees of heat in a laboratory oven at 47% RH.

Upon development, the results showed that temperatures higher than 65 C are of questionable value. Selective decomposition begins at that level, and total image destruction occurs at 75 C.

In order to achieve the shortest aging time possible, the highest practical temperature range had to be determined. A temperature of approximately 55 C was found to give the fastest practical change, with a reasonable safety margin for small temperature fluctuations. All subsequent investigations were made at that level.

Exposure and division procedures employed for the preliminary test were repeated on several lengths of different emulsions to establish whether and when latent image stability could be achieved. The emulsion lengths were treated for different lengths of time and developed simultaneously, together with untreated strips of the same exposure run. Later on these untreated strips served as references for the comparison of treatment effects.

The light and the dark patches of the test print were read under a Quantalog densitometer. The reflectance reading attachment of the densitometer had been modified to read a circle $\frac{3}{4}$ in. in diameter to eliminate local errors.

Figure 1 illustrates the results obtained. During the first 15 min no practical change takes place. After 25 min there is a slight increase in contrast. By the end of the first hour, a fairly well advanced stage of the familiar shift to a greenish balance is apparent.

While the rate of change decreases with further increase in treatment time, the change continues, especially in the higher densities, at a rate which indicates that satisfactory stabilization has not yet been achieved. After 150 min of treatment, further change becomes minute. Good stability is finally achieved after 180 min.

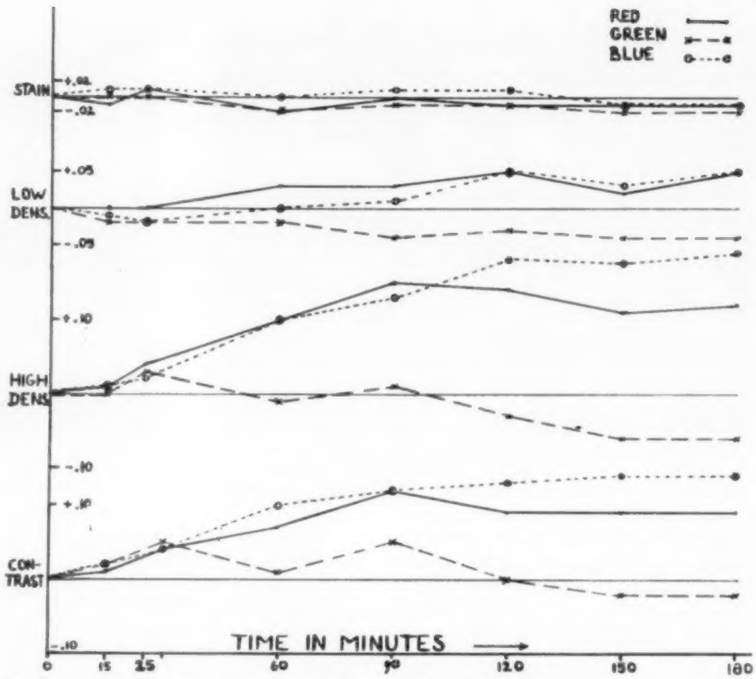


Fig. 1. Quantolog densitometer recordings of the forced aging process.

Obtaining Balance

The next step attempts to obtain force-aged images in a near normal balance range. Given time and material, a perfectly normal balance can doubtlessly be achieved. However, this is not really necessary. A method was selected which renders satisfactory results with a minimum of production interference. A normally printed test strip is divided into two portions. One part is force aged at 55 C, 47% RH, for three hours.† The strip is cooled and then developed together with the untreated portion and one of the process control strips then in use. The importance of determining the process level at the time of this test development should not be underestimated. Contrast and balance changes after forced-aging are not parallel phenomena in all emulsions. For that reason, it is imperative to know process conditions so that proper adjustments can be made to the balance of the new strips.

The developed strips are now measured for red, green and blue density, both in the light and dark areas. They are also checked for stain in the unexposed border. A predominant orange-yellow stain indicates too high a temperature level during treatment.

The readings from the treated strip are plotted, using the readings from the untreated portion as reference. Also, for easier visualization, the *difference* between

† Where accurate humidity control is not possible, aging times may be different and will have to be determined using the above data as guide.

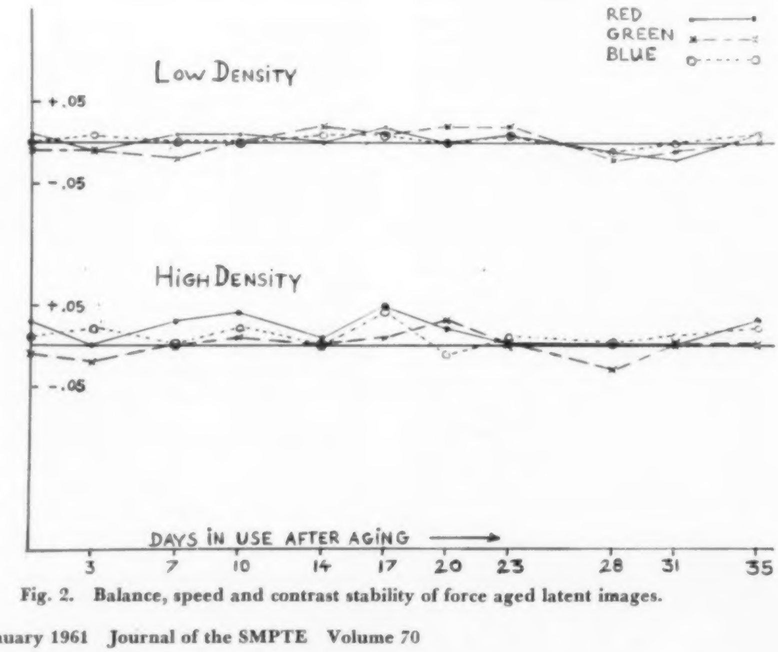


Fig. 2. Balance, speed and contrast stability of force aged latent images.

the readings of the treated light and dark areas should be plotted against the corresponding values from the untreated portion. This describes the contrast change that has taken place and helps to determine the adjustments to be made.

The deviations between the treated and untreated portions are converted to the nearest equivalent color correction buttons on the printer. A second series then is exposed, heat-treated, and developed. Visual comparison with the untreated portion of the first run should determine whether additional corrections are necessary. An absolute match will not be possible unless printer times are changed with the color balance potentiometers. For the purpose of process control, a near normal balance will suffice. The process will be expedited by using the color correction buttons only.

Next, an amount of paper suited to the individual need is exposed, in one run, with balance corrected according to the second test. It is advisable, however, to limit the size of any one roll to between 200 and 250 ft. If the bulk of the paper is large, the time lag during the heat treatment may produce a balance shift from one end of the roll to the other. The second test may be omitted after the first few treatments, as experience is gained in determining the correction magnitudes.

The cooling period for the full roll will be several hours. After room temperature is reached, the strips are ready for immediate use or cool storage.

Results

Maximum balance or contrast changes recorded over 20- to 30-day periods were not over 0.05 density. These occurred only on some emulsions, especially during the first two days of use. After that, practically full stability had been obtained.

Sensitivity to process variations is high and parallels that of fresh production paper of the same emulsion. Results are recorded in Fig. 2.

Thus, it can be concluded that a practical and effective means of obtaining reliable process control strips is now available to any processor of Ektacolor paper.

standards and recommended practices

Availability of Standards

For those interested in maintaining an up-to-date set of Standards the Society makes available a Standards Binder and a Standards Subscription Service. The Standards Binder is a sturdy looseleaf binder containing a complete set of all SMPTE-sponsored Standards and Recommended Practices in effect as of January 1, 1961. The price of $39.00 for the Standards Binder includes mailing. Subscribers to the Standards Subscription Service receive all SMPTE-sponsored American Standards and SMPTE Recommended Practices approved during the calendar year. These are forwarded to subscribers quarterly. The subscription for 1961 is $9.00.

Of the many Standards currently in work in Society Committees, it is hoped that as many as eighteen may be processed to approval as American Standards this year, and thus be available for mailing to subscribers to the 1961 Standards Service.

Other publications relating to Standards that are presently available from Society headquarters include:

International Standardization

A technical report of the third meeting of ISO/TC 36, Cinematography, held in 1958. Included is a summary of the proceedings, a list of thirty-three resolutions and the draft proposals adopted at the meeting. No charge.

Index to American Standards

A list of all American Standards and SMPTE Recommended Practices sponsored by the SMPTE. No charge.

SMPTE Recommended Practices

1. 16 & 8mm Sprocket Design
2. Magnetic Coating of 16mm Magnetic-Photographic Sound Record
3. Lens Mount Surface for High-Speed Motion-Picture Cameras
4. Reporting Photometric Performance of Incandescent Filament Lighting Units Used in Theater and Television Production
5. Patch Splices in 2-In. Video Magnetic Tape

No charge.

Proposed American Standards on Video-Tape Recording

1. VTR 16.2, Dimensions for 2-in. Video Magnetic Tape
2. VTR 16.5, Characteristics of the Audio Records for 2-in. Video Magnetic Tape Recordings
3. VTR 16.6, Dimensions for Video, Audio and Control Records on 2-in. Video Magnetic Tape.
4. VTR 16.8, Speed for 2-in. Video Magnetic Tape.

One copy, no charge; 2–25 copies, $.25 each; 26–50 copies, $.20 each; 51–99 copies, $.15 each; over 100, $.12 each.

Proposed SMPTE Recommended Practices

Published here for a three-month period of trial and criticism are two Proposed SMPTE Recommended Practices, drafted by special subcommittees of the Television Engineering Committee: RP 8, Safe Title Area for TV Transmission and RP 9, Slide Mount for 2 x 2 Slides for Television Use

The purpose of RP 8 is to specify the location of essential information which is to be reproduced by the majority of typically-operated home receivers. The subcommittee recognized the difficulty involved in specifying the safe title area since home receivers may be overscanned to compensate for variations in voltage, aging of components, etc. In preparing this specification, the committee studied related recommendations and proposals advanced by other organizations and individuals and has correlated its work with operating practices presently employed by the major broadcasters.

RP 9 was formulated to extend existing image-locating procedures used for 16 and 35mm film production to the production of slides for television. The subcommittee believes the adoption of this practice will aid the television broadcaster by providing him with an acceptable slide mount which will automatically insure correct positioning of slide material so that the original information will be accurately reproduced. The mount is intended to refine the present method of making slides for TV transmission. Adoption of this recommended practice will insure interchangeability of new slides, without making existing slides obsolete.

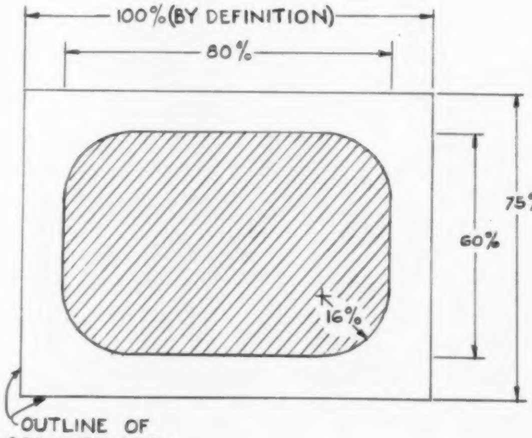
All comments should be addressed to the staff engineer prior to April 15, 1961. If no adverse comments are received, the Recommended Practices will be submitted to the Society's Board of Governors for approval. — *J. Howard Schumacher*, Staff Engineer.

Proposed SMPTE Recommended Practice RP 8

Safe Title Area for TV Transmission

1. *Scope*
   1.1 Existing standards define the camera aperture, projector aperture and scanned area for each of the media commonly used as sources of photographic material for television transmission.
   1.2 This Recommended Practice suggests restrictions on the location of essential information (e.g., titles, station call letters and sponsor identification) with the intent of insuring visibility of that information of the great majority of home receivers as typically operated.

2. *Recommended Practice*
   2.1 For any form of motion picture or slide material, titles and other essential information should be kept within the shaded portion of the drawing.
   2.2 The dimensions of the drawing are stated in terms of percent of the nominal scanned area transmitted by the television system. 100% is, by definition, equal to the width of the scanned area and 75% is then the height of the scanned area.
   2.3 For operating convenience, it is suggested the outline of the shaded area be indicated in all camera viewfinders.



Note: The safe title area should not be confused with either the safe action area or the scanned area.

3. *Reference Standards*
   3.1 The dimensions of the various scanned areas will be found in the following American Standards:
   Television Picture Area — 16mm Motion-Picture Film, PH22.96-1954
   Television Picture Area — 35mm Motion-Picture Film, PH22.95–1954
   Slides and Opaques for Television Film Camera Chains, PH22.94–1954

Proposed SMPTE Recommended Practice RP 9

Slide Mount for 2 x 2 Slides for Television Use

1. *Scope*

1.1 This recommended practice specifies (a) the location and dimensions of the photographic camera or printer aperture for those cameras used to provide source material for 2 x 2 slides for television use, and (b) the dimensions of the slide mount for 2 x 2 slides for television use.

1.2 The object is to obtain 2 x 2 slides whose picture information is accurately and consistently positioned with respect to all edges.

Table I

Dimensions	Inches	Millimeters
A	0.964 ± 0.004	24.49 ± 0.10
B	1.429 ± 0.004	36.30 ± 0.10
C	0.0935 ± 0.0010	2.375 ± 0.025
D	0.688 ± 0.001	17.48 ± 0.03

Table II

Dimensions	Inches	Millimeters
A	0.555 ± 0.002	13.39 ± 0.05
B	0.468 ± 0.002	11.89 ± 0.05
C	0.108 ± 0.002	2.74 ± 0.05
D	$0.072 \begin{smallmatrix}+0.001\\-0.002\end{smallmatrix}$	$1.83 \begin{smallmatrix}+0.03\\-0.05\end{smallmatrix}$
E	$2.000 \begin{smallmatrix}+0.000\\-0.005\end{smallmatrix}$	$50.80 \begin{smallmatrix}+0.00\\-0.13\end{smallmatrix}$

2. *Dimensions*

2.1 The location and dimensions of the photographic camera or printer aperture shall be as given in Figure 1 and Table I.

2.2 The dimensions of the slide mount shall be as given in Figure 2 and Table II.

2.3 The minimum dimensions of the picture background (aperture) shall be: height 0.906 in. (23.01 mm); width 1.344 in. (34.14 mm), in accordance with American Standard Slides and Opaques for Television Film Camera Chains, PH22.94–1954, or the latest revision thereof approved by the American Standards Association, Incorporated.

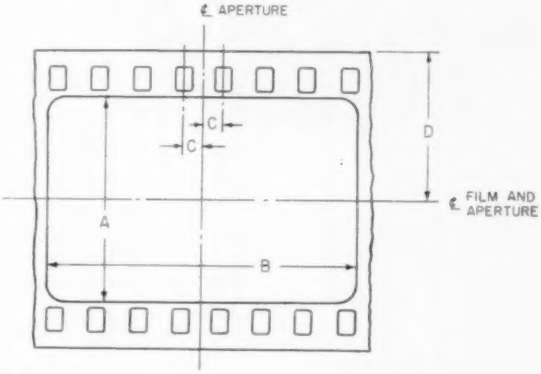
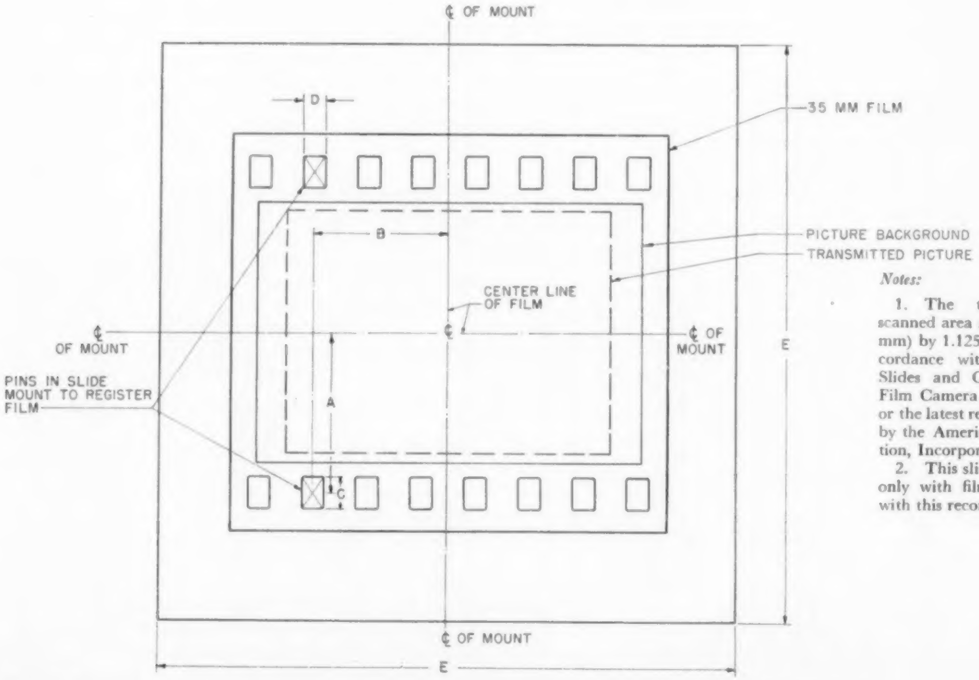


Figure 1



Notes:

1. The transmitted picture or scanned area shall be 0.844 in. (21.44 mm) by 1.125 in. (28.58 mm), in accordance with American Standard Slides and Opaques for Television Film Camera Chains, PH22.94-1954, or the latest revision thereof approved by the American Standards Association, Incorporated.

2. This slide mount is to be used only with film made in accordance with this recommended practice.

Figure 2

International Standardization

The International Organization for Standardization (ISO), whose activities in the field of cinematography were described in the January 1959 Journal report, pp. 32–37, has recently adopted two Recommendations which are published here for the general information of the SMPTE membership. Recommendation R 162 is in substantial agreement with American Standard PH22.86-1953, and Recommendation R 163 agrees with American Standard PH22.101-1956. This now brings the total of ISO Recommendations adopted to fifteen. The first seven were published in the December 1957 SMPTE Journal and six in the December 1959 issue.

The members' attention is directed to the fact that only the technical content of the Recommendations is published here. Copies of the complete documents including a brief history of the origin of each Recommendation are available from the U. S. member of the ISO, the American Standards Association, 10 E. 40 St., N. Y. 16, for a nominal fee.—*J. Howard Schumacher*, Staff Engineer.

ISO/R 162 - 1960 (E)

ISO Recommendation R 162 July 1960

LOCATION OF RECORDING HEADS FOR THREE MAGNETIC SOUND RECORDS ON 35 mm FILM AND ONE MAGNETIC SOUND RECORD ON 17.5 mm FILM

1. SCOPE

This ISO Recommendation specifies the location and dimensions of the magnetic sound recording heads for recording up to three magnetic sound records on 35 mm motion-picture film and one magnetic sound record on 17.5 mm motion-picture film.

This ISO Recommendation relates the placement of the magnetic coating on the film to the direction of film travel.

2. DIMENSIONS

The dimensions are as specified in the figure and the table below.

3. SOUND RECORDS

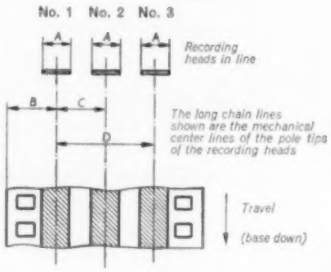
Head No. 1 should be employed when recording a single sound record on 35 mm film.

Head No. 1 should be employed for recording the sound record on 17.5 mm film.

4. MAGNETIC COATING

With the direction of film travel shown in the figure, the magnetic coating is on the upper face of the film base.

Dimension	Millimetres	Inches
A	$5.0^{+0.1}_{-0}$	$0.200^{+0.004}_{-0}$
B	8.6 ± 0.05	0.339 ± 0.002
C	8.9 ± 0.05	0.350 ± 0.002
D	17.8 ± 0.05	0.700 ± 0.002



Note: The millimetre and inch dimensions represent acceptable practice, though positions of the outer tracks differ slightly in the two systems. The advantage of round numbers in both systems justifies the differences.

ISO/R 163 - 1960 (E)

ISO Recommendation R 163 July 1960

MAGNETIC STRIPING OF 16 mm FILM PERFORATED ALONG BOTH EDGES

1. SCOPE

This ISO Recommendation specifies the location and dimensions of the magnetic coating material when applied to 16 mm motion-picture film to be used for both picture and sound.

2. DIMENSIONS

The dimensions are as specified in the figure and the table below.

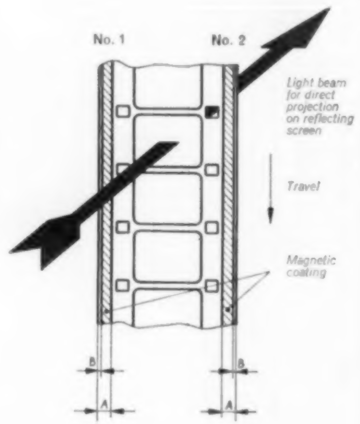
The magnetic coating is on the side of the film toward the lamp in a projector arranged for direct projection on a reflecting screen.

3. SOUND RECORD

The sound record should be placed on track No. 1.

Track No. 2 is provided primarily as a balance stripe, but may be used for a secondary sound record.

Dimension	Millimetres	Inches
A	$0.80^{+0}_{-0.1}$	$0.031^{+0}_{-0.003}$
B	max. 0.05	max. 0.002



The Spring Convention

TORONTO, CANADA

King Edward-Sheraton Hotel

May 7–12, 1961

International Achievements in

Motion Pictures and Television

THE INTERNATIONAL theme of the 89th Convention of the Society is attracting special attention in overseas countries. According to Local Arrangements Committee Chairman Gerald Graham, indications have already been received that representatives from Italy, Sweden, England, France, Czechoslovakia, the Union of South Africa, and the USSR will attend the meeting.

"International Achievements in Motion Pictures and Television," is the theme of the week-long convention scheduled to take place May 7–12, at the King Edward-Sheraton Hotel in Toronto, Canada.

Convention arrangements are speeding along at such a pace that all past records for early preparations will probably be broken. Social Arrangements Committees report great progress. The Get-Together Luncheon on Monday of Convention Week will feature an address of great interest by a prominent Canadian member of the industry. There will also be a timely report presented at the Luncheon by a well-known Canadian newscaster.

The Program Chairman and Local Arrangements Chairman are busy this month putting together preliminary details about the technical program and other events for inclusion in the general Announcement of the convention which will be mailed to members early in March. Although there will be no Advance Registration this time, it will still be possible, and desirable, to make hotel reservations ahead of time, and a reservation card for this purpose, addressed to the King Edward-Sheraton, will be a part of the Announcement.

Papers Program

Program Chairman Rodger J. Ross indicates that the program should be well set by mid-February. Mr. Ross's statement came after a report from Topic Chairman that some of the technical papers sessions were in fine form early in January. However, authors are urged to observe the February 12th deadline for the submission of abstracts and author forms.

One interesting item of advance information from Mr. Ross is that Technicolor Corp., whose participation in technical programs of SMPTE and elsewhere has been something of a rarity, plans to present no less than four papers, two from its Hollywood installation and two from its English and Italian companies. These will be: "Evaluation of Negative Exposure via an Arbitrary Scale," by W. E. Pohl; "Technirama 70," by D. S. Nickolson; "International Facilities for Release Printing by Technicolor," by L. B. Happe; and "Selective Printing," by I. Tinari and W. B. Tucker.

Equipment Exhibit

Ken Oakley, the Exhibit Chairman, reports that a display of products and services is already assured that alone will warrant a visit to the Convention. At the time of writing, well over three months before the Convention opens, all the space planned for booths has apparently been reserved and the matter of finding additional space is under consideration.

Many U.S. companies are making the trip to Toronto to show equipment in this Exhibit, which will have quite an international flavor — especially so since many of the Canadian concerns represented will be showing products from Europe. Thus far, the following companies have taken space for displays:

Beckman & Whitley, Inc. (U.S.)
Bell & Howell Co. (U.S.)
Behrend Cine Corp. (U.S.)
Berndt-Bach, Inc. (U.S.)
Birns & Sawyer Cine Equipment, Inc. (U.S.)
Braun of Canada Equipment Ltd. (Canada)
Caldwell A/V Equipment Ltd. (Canada)
Camera Equipment Co. (U.S.)
Canadian Broadcasting Corp. (Canada)
Canadian Applied Research Ltd. (Canada)
Alex L. Clark Ltd. (Canada)
Eastman Kodak Co. (U.S.)
Ferrania Div., Viditon Corp. (Canada)
Film Editing Equipment, Inc. (U.S.)
Florman & Babb, Inc. (U.S.)
Harwald Co. (U.S.)
Philip A. Hunt Co. (U.S.)
Lipsner-Smith Corp. (U.S.)
MacKenzie Equipment Ltd. (Canada)
Magnasync Corp. (U.S.)
McCurdy Radio Industries Ltd. (Canada)
Precision Cine Equipment Div. (U.S.)
Robert Rigby Ltd. (England)
L. B. Russell Chemicals, Inc. (U.S.)
S.O.S. Cinema Supply Corp. (U.S.)
Strand Electric Ltd. (Canada)
Wollensak Optical Co. (U.S.)

Anyone interested in participating, if further space becomes available, should get in touch immediately with Kenneth S. Oakley, c/o Bell & Howell Canada Ltd., 88 Industry St., Toronto 15, Ont. (RO-7-3131).

Ladies Program

Details are now beginning to come in from Frank Tate, Chairman of the Ladies Committee, indicating that ladies from both sides of the border can count on a full week of interesting activities. A pre-release film on Sunday night and a get-together tea on Monday, sponsored by Photo Importing Agencies Ltd., will start the week. On Tuesday there will be a trip to Niagara Falls, with lunch at the Brock Hotel, courtesy of Minnesota Mining & Manufacturing of Canada Ltd. Other events planned are a visit to CBC for the "Front Page Challenge" program; a cocktail party sponsored by the National Film Board of Canada; and a tour of Casa Loma, famed replica of a battlemented medieval castle, with tea served courtesy of Alex L. Clark Ltd.

At various times during the week there will be opportunity for shopping and sightseeing around Toronto, with guides and transportation provided. Those who plan to stock up on some of the attractive Canadian and imported British goods available in the Toronto stores should note that two hundred dollars' worth of merchandise may be brought into the United States, duty free, by visitors who have spent more than forty-eight hours in Canada and who have not claimed a similar exemption during the past thirty days.

Stepped-up publicity activities are taking place following a meeting in Toronto early in January which included Local Arrangements Committee Chairman Gerald Graham, Local Arrangements Committee Vice-Chairman Roger Beaudry, Publicity Committee Co-Chairmen Arthur Benson and Frank Young, Program Chairman Rodger J. Ross, National Film Board of Canada Publicity Director Tom Johnston, and SMPTE Public Relations Director Barbara Skeeter. Veteran motion-picture editor Hye Bossin of the *Canadian Film Weekly* met with the group for discussion of the particular problems to be encountered in the publicity program.

The Association of Motion Picture Producers and Laboratories of Canada has scheduled its Annual Meeting to coincide with the 89th Convention. According to present plans, the AMPPLC will meet at the Westbury Hotel on Friday, May 12. This will be followed by a special form of panel discussion on Saturday morning, May 13, at the King Edward-Sheraton, and and Canadian Film Awards luncheon, in collaboration with the Canadian Film Institute, which will also take place in the King Edward-Sheraton.

The SMPTE Coffee Club, always a popular feature of the Society's conventions and a useful center both for business and refreshment, will be sponsored on this occasion by Kodak Ltd., of Toronto.

Harry Teitelbaum, Convention Vice-President, will meet with Local Arrangements Committee chairmen and officials of the King Edward-Sheraton in Toronto early this month to consolidate plans for the meeting.

With the wonderful cooperation being offered SMPTE arrangements officers by the Canadian industry and news outlets and the intense interest being generated in Canada, the United States and in overseas countries, the convention seems destined for success. All members and their wives and other interested persons are urged to attend the convention and participate in an alive and interesting program and enjoy one of Canada's most fascinating cities.—*B.S.*

Education, Industry News

Activities of the East Coast Education Committee

The East Coast Subcommittee for Audio-Video Recording, under the chairmanship of Arthur E. Fury, will sponsor a lecture on video-tape recording at Reeves Sound Studio B in New York City on February 9th. Lecturers Robert Byloff, Manager of Video Recording at Reeves Sound, and Julian Bernstein, an instructor in video recording at RCA Institutes, will present nontechnical introductory talks on video recording.

This first meeting will serve as a preface to a series of seven technical lectures on video-tape recording which will begin on March 16th. During the series, specialists will cover various subjects from the viewpoint of operating and maintenance personnel.

Edgar Schuller, Chairman of the East Coast Education Committee, reports that the Committee is presently studying the feasibility of the publication of a handbook on sound recording.

According to Mr. Schuller, the Committee would like to see a useful handbook made available to motion-picture and television sound recording technicians. The material which the Committee suggests be contained in the handbook may be found in textbooks; however, it is the opinion of the Committee that a compilation of these materials under one cover would be of immense value to the industry.

In general, the Committee would like to see the handbook cover original recording and associated problems as well as how the original recording quality may affect the quality of the intermediate and final soundtracks on various media. Other headings should be preventive maintenance and troubleshooting, procedures for operation and the tools, equipment and services available to the recording technician.

A meeting of all subcommittee members has been called for the purpose of reviewing the goals and current activities of the three New York Education Subcommittees. It is anticipated that this review and re-evaluation of the subcommittees' operations will result in more effective contributions to the Society.

The Education Committee has engaged in extensive cooperation with the Student Chapter at City College of New York. Wallace Robbins of Camera Equipment Company conducted the group on a tour of his company's facilities. Pathe Laboratories Production Supervisor, Richard Lebre, conducted a similar tour of the Pathe facilities for the student members. Also, the CCNY group attended a pre-release screening of a feature film at Twentieth Century-Fox Film Corporation's Studios. Jack Brotsky of Twentieth Century-Fox arranged the screening.

The first program over a recently installed closed-circuit TV network at the University of California, Los Angeles, was transmitted January 9. Originating in a 6th grade classroom in the University's Elementary School, the program was viewed in a teacher training classroom in the School of Education, about half a mile from the point of origin. Advantages of TV viewing over "live" classroom observation were outlined by Rudy Bretz, Head of Educational TV for University Extension, UCLA. Among the advantages, he noted a minimum of disturbance in the demonstration classroom when small, remotely-controlled TV cameras took the place of 30 to 40 observers. Other experiments exploring the educational possibilities of the network are being planned.

Fifteen evening and Saturday classes in film making are offered by the Institute of Film Techniques, City College, New York, for the Spring semester. Announcement was made by Yael Woll, Director of the Institute. Courses will cover photography, script writing, sound and film editing, directing and production. Elementary classes are open to students without previous film training or college background. Advanced courses are offered for those already having some experience.

The Inter-Society Color Council will hold its 30th Annual Meeting April 10–12, 1961, at the Sheraton Hotel, Rochester, N.Y. Plans include a two-day Symposium on the general subject of "Color in Photography and Television." Further information is available from Ralph M. Evans, Secretary, Inter-Society Color Council, Color Technology Div., Bldg. 65, Eastman Kodak Co., Rochester 4, N.Y.

The 1961 IRE International Convention will be held March 20–23 at the Waldorf-Astoria Hotel and the New York Coliseum, New York. About 275 papers are scheduled for presentation at 54 Sessions. A special feature of the Tech-

nical Program will be a Symposium on New Energy Sources, set for the evening of March 21. Among Sessions of special interest is Session 37 on Communication Systems — Basic Theory. A paper on "Statistics of Hyperbolic Error Distribution in Data Transmission," by Pierre Mertz will be presented. Dr. Mertz is Chairman of the SMPTE's Board of Editors.

The 4th International Conference on Medical Electronics and the 14th Annual Conference on Electrical Techniques in Medicine and Biology will be held jointly July 16–21, 1961, at the Waldorf-Astoria, New York. The Conference is sponsored by the Joint Executive Committee on Medicine and Biology (IRE, AIEE, ISA) under the auspices of the International Federation for Medical Electronics. It is organized by the IRE through its Professional Group on Bio-Medical Electronics. Program Chairman is H. P. Schwan of the University of Pennsylvania. The theme of the Conference covers a broad scientific area common to the engineering, medical and biological fields. Topics of discussion are expected to include models of biological systems, physiological monitoring, system analysis, electrical and radiation stimulation study, automation, instrumental diagnostic methods, data analysis techniques, physical-chemical procedures and related topics.

The Industry Film Producers Association will hold its 2d Annual Convention and Trade Show June 2–3, at the Miramar Hotel, Santa Monica, Calif. Convention Chairman is Jack C. Williamson, with Headquarters at Paul Garrison Organization, 10323 Santa Monica Blvd., Los Angeles 25.

Seventy-six members of the IRE were advanced to the grade of Fellow by action of the Board of Directors which met November 14 in Boston. The highest membership grade offered by the IRE, the grade of Fellow, is bestowed by invitation on individuals who have made outstanding contributions to radio engineering or allied fields. Among those honored are SMPTE members J. F. Fisher, Engineering Section Manager, Philco Corp., Philadelphia, Pa.; A. C. Keller, Director, Switching Systems Division, Bell Telephone Laboratories, Inc., New York; and A. M. Zarem, President, Electro-Optical Systems, Inc., Pasadena, Calif.

Independent producer Emerson Yorke is currently filming a documentary at Carthay Studios about Toastmasters International, a nonprofit organization with some 80,000 members in 3200 affiliated toastmaster clubs. The film is to have the title, *Accustomed as I Am*, and will be based on a recent *Reader's Digest* article with the same title. The film will outline the origin and growth of the organization.

Recent appointments announced by Elgeet Optical Co., Rochester, N.Y., include Andor Fleischman, Director, Optical Engineering; and Manny Kiner, Director, Special Products Division. A native of Budapest, Mr. Fleischman received his early education in Tel Aviv, Israel. He was granted a Bachelor of Science Degree in Physics by New York University in 1953 and a Masters Degree in Optics by the University of Rochester in 1955. Prior to his present appointment, he was an optical specialist at Aerojet-General, with emphasis on infrared systems and interference filter design. Mr. Kiner was granted a bachelor of Science Degree in Optics by the University of Rochester in 1953. He has been associated with Elgeet since 1952.

Charles F. Schwep has been appointed Manager of the Visual Communications and Training Department, a new unit of the American Management Association. The new department includes video-tape equipment and closed-circuit TV as well as motion-picture facilities. Mr. Schwep, formerly President of Trident Films, Inc., New York, has produced, written or directed more than 60 documentary films. He has also acted as consultant on motion pictures to the Commissioner General of the Brussels World's Fair and has been Chairman of the Film Selection Committee for the U.S. Theatre.

Bert Spielvogel has been appointed Director of Cinematography for On Film, Inc., of Princeton, N.J., and New York. His responsibilities include supervision of

MICROFLASH This photograph made with newly developed EG&G Microflash (below). Light duration: .5 microsecond. Peak Light: 50×10^6 horizontal candle power. Energy input: 8 w.s. (0.05 mfd @ 18 kv.). Plus-X, f/11. Price: $975.00 F.O.B. Boston. (Delivery from stock.)

ultra-high performance photographic equipment

FLASH ILLUMINATOR Safe source of cool, high intensity light for extreme close-ups and microscopic work. Color or black and white. Eliminates heat damage of delicate subjects. Incandescent focus light included.

501 STROBOSCOPE for high-speed motion pictures. 1.2 μsec. flashes up to 6,000 c.p.s. Time jitter less than 100 Mμsec.

LS-1 FLASH UNIT illuminates large areas for night aerial photography, etc. 635 w.s. light output, 26,000 to 88,500 beam c.p., depending on beam angle.

LS-10 MULTI-FLASH Multiple discharge units permit superimposed images on single negative for stress and strain studies, ballistic measurements, etc. 1 microsecond flash duration — max. rate 100,000 flashes per second.

RAPATRONIC CAMERA Magneto-optic shutter permits 0.8 μsec. exposures of self-luminous events.

SUN FLASH duplicates sunlight with only slight filtering for normal color films. Approx. 10,000 w.s. per flash. Duration: 1/250 sec. to 1/10 of peak light. Charging cycle: 30 seconds.

303 STROBOSCOPE for observing large, rotating objects. Flashes up to 60 per second. Total duration 25 microseconds.

XENON FLASH TUBES FX-6A has billion flash life. FX-29 offers 2500 horizontal candle power. Many others with varied special characteristics. Ideal for computers, test instrumentation, laser stimulators, etc.

DOUBLE-FLASH Complete, portable system for short duration, double-exposure shadow photography at accurately timed intervals.

MARK VI SENSITOMETER Uniformity of repeated exposure ensured to within ±5%. Light closely approximates daylight. Ideal for process control.

EG&G

EDGERTON, GERMESHAUSEN & GRIER, INC.

178 BROOKLINE AVENUE, BOSTON 15, MASSACHUSETTS • TEL. COPLEY 7-9700 • CABLE: EGGINC, BOSTON; TWX: BS 1099
WESTERN OPERATIONS: P.O. Box 1912, Las Vegas, Nev. — Santa Barbara Airport, P.O. Box 98, Goleta, Calif.

PRODUCTS — milli-mike® Oscilloscopes • Hydrogen Thyratrons • Xenon Flash Tubes • Dosimeters • Flash Machines & Circuits • Oceanographic Equipment Transformers • CAPABILITIES — Project Management • Systems Engineering • Research & Development

EG&G TECHNICAL REPRESENTATIVES — NEW ENGLAND, BOSTON, MASS. — 160 Brookline Ave., COpley 7-9700
J. D. Ryerson Assoc., Inc. — SYRACUSE, N. Y., P. O. Box 1400, 111 Kinne Road, GIbson 6-1771 • **G. Curtis Engel & Assoc., Inc. — RIDGEWOOD, N. J.,** 210 South Broad Street, GIlbert 4-1400; **PHILADELPHIA, Pa.,** WAlnut 2-3270 • **S. S. Lee Assoc., Inc. — ORLANDO, Fla.,** P. O. Box 7896, CHerry 1-4445; **WINSTON-SALEM, N. C.,** P. O. Box 906, STate 8-0431; **HUNTSVILLE, Ala.,** Utilities Bldg., Room 300, JEfferson 6-0631; **WHEATON, Md.,** 2521 Ennalls Avenue, LOckwood 5-3066; **TOWSON, Md.,** 21 Pennsylvania Ave., VAlley 3-3434 • **Dayton Assoc. — DAYTON, O.,** Talbot Tower — Suite 1318, BAldwin 3-9621; **CLEVELAND, O.,** 8211 Avery Road, JAckson 6-3990; **CINCINNATI, O.,** 4924 Zula Avenue, BAckburn 1-2349; **SOUTHGATE, Mich.,** 15332 Kennebec, AVenue 5-3125 • **Midwest Electronic Sales — CHICAGO, Ill.,** 3800 West North Ave., CApitol 7-3222 • **Engineering Production Assoc. — ST. PAUL, Minn.,** 1821 University Avenue — Rm. 182, Midway 6-3443 • **Gene French Co. — ALBUQUERQUE, N.M.,** 7900 Zuni Road, S.E., AMherst 8-2478; **SALT LAKE CITY, Utah,** 138 South Second East, EMpire 4-3057; **DENVER, Col.,** 1480 Hoyt, MAin 3-1458; **SCOTTSDALE, Ariz.,** 224 South Hinton Avenue, WHitney 6-3504 • **Kinrick Co. — ST. LOUIS, Mo.,** 222 Olympia Drive, JAckson 1-4877, MAin 1-1421 • **Stanley Enterprises — SEATTLE, Wash.,** 127 River Street, PArkway 3-3320 • **Mitchell Speairs Co. — FORT WORTH, Tex.,** 4944 James Avenue, WAbash 3-4657 • **J. T. Hill Co. — SAN GABRIEL, Calif.,** 420 South Pine Street, ATlantic 7-9633 ,CUmberland 3-6555; **SAN CARLOS, Calif.,** 1682 Laurel Street LYtell 3-7693; **SAN DIEGO Calif.** 1864 Bacon Street, ACademy 3-7138.

all camera work including animation, supervision of aerial image projector effects and coordination of activities with the Motion Picture Film Research and Design Department. Prior to his present appointment he operated a motion-picture studio in Washington, D.C., where, among many other assignments, he produced a number of films for On Film. Early in his career, he worked with Robert Flaherty and the original Cinerama group. He has also been on the teaching staff of American University, Washington, D.C., as Instructor in Cinematography.

H. B. Chandler, of Montreal, has been appointed Senior United States Representative of the National Film Board, with headquarters in Canada House, New York. He succeeds J. W. Cosman who has returned to Montreal as Chief of Film Sales Division, NFB. Prior to his present appointment, Mr. Chandler was Assistant Chief of the International Division, NFB. Part of his activities included supervision of the distribution in the United States of Canadian travel films.

Hans Stauder has been appointed President and General Manager of Paillard, Inc., the U.S. subsidiary of Paillard S.A., Yverdon, Switzerland. Mr. Stauder joined Paillard as Vice-President when it was founded in New York in 1949. Prior to his present appointment he was Executive Vice-President and General Manager.

Walter Rybka has been appointed Director of Technical Operations of Paillard, Inc., N.Y. He will be in charge of technical operations, including all phases of equipment evaluation for the improvement and development of Bolex 8mm and 16mm motion-picture equipment as well as other photographic products.

George E. Spaulding, Jr., has been elected to the newly created post of Vice-President of Engineering Operations, Photo Products Division, Bell & Howell. In his new post he will be responsible for manufacturing and design engineering functions and for quality standards. For the past twelve years, he has been associated with Electric Autolite Co., Toledo, Ohio, where he served as Director of Research and General Manager of the SPARD Division.

Arthur Cox has been elected an Assistant Vice-President of the Photo Products Division of Bell & Howell. In this post he will be responsible for the design and development of photo-optics within the division and will act in an advisory capacity in the field of optics for other divisions of the firm. He has been with Bell & Howell since 1952 and previously was head of the Scientific Department of Farrand Optical Co.

Announcement of the appointment of Adolph H. Rosenthal to the newly created post of Scientific Advisor to the President has been made by Kollsman Instrument Corp., Elmhurst, N.Y. The firm has also created a Research Division to study areas of development including infrared, ultrasonic, information handling, analysis and communication and related fields. Internationally known as an authority in applied physics research, Dr. Rosenthal is the inventor of the dark trace cathode-ray tube, and holds more than 30 U.S. Patents in subscriber and color television, light modulation and display and recording methods. Prior to his present appointment he was Vice-President of Fairchild Controls Corp. and Senior Research Program Director of Fairchild Camera and Instrument Corp.

Roger Tilton has been appointed head of the Motion-Picture Department of Brooks Institute of Photography, 2190 Alston Rd. Santa Barbara, Calif. Producer of a number of cultural and educational films, one of his films, *Jazz Dance*, won two awards in 1955, the Award of Merit at the Edinburgh Film Festival and the Special Award of the Robert Flaherty Documentary Film Competition. His earlier teaching posts included the City College of New York and Columbia University.

J. Drayton Hastie has been appointed President of the Broadcasting Division of Reeves Broadcasting and Development Corp. He was formerly a Vice-President of the firm. Another Vice-President, Chester L. Stewart, has been named President of Reeves Sound Studio Division, New York. Mr. Hastie's new headquarters will be in Charleston, S.C. The Division operates television stations WUSN-TV, Charleston; KBAK-TV, Bakersfield,

Calif.; and, subject to FCC approval, WHTN-TV, Huntington, W. Va.

A new corporation, the Shafford Electronics & Development Corp., 2945 Nebraska Ave., Santa Monica, Calif., has been formed. Emphasis will be on avionics and spacetronics control systems, according to an announcement by Clifford A. Shank, President and Chairman of the Board.

The new Aero Systems Engineering, a Division of Aero Service Corp., 210 E. Courtland St., Philadelphia 20, is staffed to undertake research, development system design tasks, and operational programs in fields related to photogrammetry, geophysics, simulators, training devices, data handling and analysis and avionic tests. Its services and capabilities are described in a beautifully illustrated booklet which suggests the wide scope of its accomplishments.

Methods of foam inflation and the development of radiation-resistant plastic foam materials are being studied by scientists at the Astro-Electronics Division, Radio Corp. of America, Princeton, N.J., with a view toward developing a technique for setting up large structures in space. This line of research was discussed by Carl C. Osgood in a paper prepared for presentation at the annual West Coast meeting of the American Astronautical Society. Space structures under consideration for the near future include extensive solar energy collectors and radar antennas 60 ft or more in diameter. Space stations and special-purpose satellites may be built with balloon-like tubes that can be folded into compact packages for launching and inflated automatically in space with a plastic foam hardened by the heat of the sun.

The modernization program of Consolidated Film Industries, a division of Republic Corp., begun in 1960, includes the installation of two specially-designed film-processing machines in its Fort Lee, N.J., laboratory. The machines were designed and built by Republic Corp.'s West Coast Laboratories. Consolidated is also increasing cutting-room facilities maintained at its New York headquarters, and is modernizing projection facilities to accommodate present and future requirements of motion-picture and television clients.

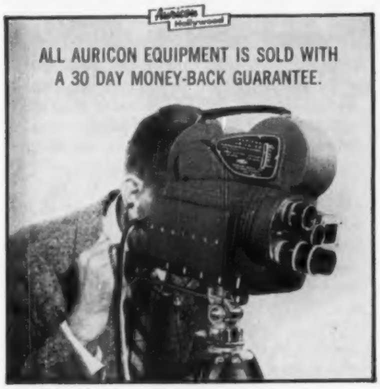
A revised price list for "Scotch" brand video tape No. 179, showing a 10% reduction in price for all sizes, has been announced by Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. This is the fourth price reduction in two years. In making the announcement, the company credited the reduced price to "improved methods of making the tape," in spite of "the trickiness of quality controlling such a product in which tolerances are held to 30-millionths of an inch."

Du Pont's Photo Products sales activities will be transferred from the present New York District Sales office location together with its warehousing facilities to Secaucus, N.J. A new building planned to double office and warehouse space is under construction on a 20-acre site near the southwest intersection of the New Jersey Turnpike and Route 3. It is expected to be completed by mid-1961. The new warehouse is planned to expedite deliveries to New York. It is located near the Lincoln Tunnel and is accessible to trucking terminals and major trucking routes.

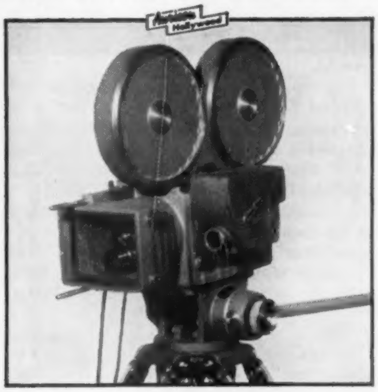
The hot splicers produced by Hollywood Film Co. are now available in "sturdy, attractive and functional" custom-built cases, according to a recent announcement. In addition to the hot splicer each case contains a pint of film cement, a pint of acetone and 100 scraping blades. The firm also announced availability of a complete line of 70mm hot splicers.

A series of Symposia on motion-picture production has been arranged by three leading equipment manufacturers, beginning Feb. 14–16, in Kansas City, Mo. Subsequent meetings will be held Feb. 20–21, in Dallas, and Mar. 31–Apr. 1, in Santa Monica, Calif. Later meetings are planned for Salt Lake City, San Francisco and Seattle. Discussions, based on question-and-answer sessions, will center around displays of equipment. Participating jointly in the venture are Arriflex Corp. of America, Magnasync Corp., and Natural Lighting Corp.

AURICON 16mm Sound-On-Film for Professional Results!

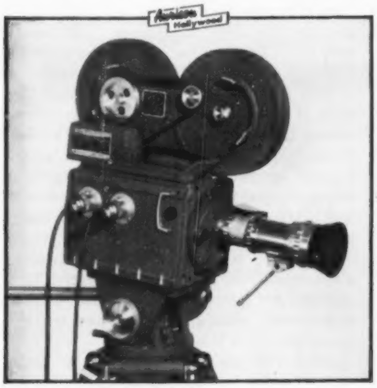


"CINE-VOICE II" 16 mm Optical Sound-On-Film Camera. ✱ 100 ft. film capacity for 2¾ minutes of recording; 6-Volt DC Convertor or 115-Volt AC operation. ✱ $967.00 (and up).



"AURICON PRO-600" 16mm Optical Sound-On-Film Camera. ✱ 600 ft. film capacity for 16½ minutes of recording. ✱ $1871.00 (and up) with 30 day money-back guarantee.

"SUPER 1200" 16 mm Optical Sound-On-Film Camera. ✱ 1200 ft. film capacity for 33 minutes of recording. ✱ $5667.00 (and up) complete for "High-Fidelity" Talking Pictures.



"PRO-600 SPECIAL" 16mm Light-Weight Camera. ✱ 400 ft. film capacity for 11 minutes of recording. ✱ $1,295.00 (and up).

PORTABLE POWER SUPPLY UNIT—Model PS-21...Silent in operation, furnishes 115-Volt AC power to drive "Single System" or "Double System" Auricon Equipment from 12 Volt Storage Battery, for remote "location" filming. ✱ $269.50

FILMAGNETIC—Finger points to Magnetic pre-stripe on unexposed film for recording lip-synchronized magnetic sound with your picture. Can be used with all Auricon Cameras. ✱ $960.00 (and up).

TRIPOD—Models FT-10 and FT-10S12... **Pan-Tilt Head Professional Tripod for velvet-smooth action. Perfectly counter-balanced to prevent Camera "dumping."** ✱ $406.25 (and up).

Strictly for Profit
CHOOSE AURICON

If it's profit you're after in the production of 16 mm Sound-On Film Talking Pictures, Auricon Cameras provide ideal working tools for shooting profitable Television Newsreels, film commercials, inserts, and local candid-camera programming. Now you can get Lip-Synchronized Optical or Magnetic Sound WITH your picture using Auricon 16 mm Sound-On-Film Cameras. Precision designed and built to "take it."

Strictly for Profit—Choose Auricon!

BACH AURICON, Inc.
6946 Romaine St., Hollywood 38, Calif.
HOllywood 2-0931

Write for your free copy of this 74-page Auricon Catalog

✱ Auricon Equipment is sold with a 30-day Money-Back Guarantee. You must be satisfied.

MANUFACTURERS OF PROFESSIONAL 16MM CAMERAS SINCE 1931

section reports

The Atlanta Section met on January 10 at the U.S. Public Health Communicable Disease Center with an attendance of 41. Guest speaker was Dr. James Lieberman, Chief, Audio-Visual Section, Training Branch of CDC, whose subject was "Audio Visual Communication in Public Health."

Dr. Lieberman outlined in brief the growth of the Communicable Disease Center from its original inception in 1942 as an organization called Malaria Control in War Areas (MCWA). At the end of World War II, MCWA was disbanded and the Communicable Disease Center was formed.

The center has the primary function of prevention and control of infectious diseases and operates through state and federal health departments and foreign field stations in the lesser developed areas of the world.

It was noted that the CDC Audio-Visual Section was unique in that it is comprised of bio-medical (photomicrography), audio-visual (motion pictures and slide films) and photographic (still photography) personnel.

A number of film clips from various CDC audio-visual productions in black-and-white and color were shown in conjunction with Dr. Lieberman's talk. One film in particular which seemed to capture the attention of all present was a 16mm color close-up sequence showing the hatching of a mosquito from the larva to the adult stage. Films of this type are frequently used in demonstrating malaria control techniques.

Motion pictures, slides and slide films produced by CDC are used in orientation of personnel in the Public Health Service and as valuable aids in the Department of Health Mobilization for Civil Defense.

After the talk, members and guests were conducted on a tour of the Audio-Visual Section, which includes a graphic arts department, motion-picture processing laboratory, recording studio, silent and sound stages for the production of full-scale motion pictures.

The attendance at this meeting was one of the largest we have had with several out-of-state guests attending. We were fortunate in having with us SMPTE Section Vice-President Garland C. Misener.

Those present indicated that they felt that they had a better understanding of the importance of audio-visual communication in safeguarding the nation's health, following the meeting.—John C. Horne, *Secretary-Treasurer*, 404 Page Ave., N.E., Atlanta 7, Ga.

The Chicago Section met on December 6 at the Cinema Processors Laboratory and the CBS Studios with an attendance of 80.

This meeting consisted of an inspection tour of the facilities of the Cinema Processors Laboratory and WBBM-TV Studios. SMPTE members assembled at the former where they toured the facilities which are almost completely devoted to the processing of black-and-white 16mm news films for showing on CBS Television News shows. At this lab complete facilities are available for developing negative films making contact positive prints, positive developing, editing, splicing, and correlation with the TV script.

After completing this tour, the group walked three blocks to the CBS Studios for an interesting tour of that plant. Here major points of interest included the news and copy rooms, the TV control rooms, and the studio where the final TV news program is telecast. Of particular interest to the group were the projectors on which the news shorts were run, and how they were controlled with flawless timing during the news telecast.

Prior to the sessions, a meeting of the Board of Managers was held at the offices of Behrend Cine Corp., during which plans for the coming year's program and the SMPTE-sponsored course at Northwestern University were discussed.—Philip E. Smith, *Secretary-Treasurer*, c/o Eastman Kodak Co., 122 South Prairie Ave., Chicago 16, Ill.

Ninety members of the Hollywood Section met on December 20 at Moody Institute of Science in Los Angeles to hear three speakers. Edward H. Reichard, Consolidated Film Industries, discussed "Control Techniques in Film Processing"; John F. Scales, Armed Forces Radio and TV Service, explained the operations of the AFRTS; and Ralph Sogge, Magnasync Corp., explored "The Large and Small in Mobile Recording Channels."

Moody Institute provided the opening film for this meeting—the recently

completed production "Sense Perception, Part 2—The Limitation of the Senses." The technical excellence of the film, as well as the thought-provoking message, narrated by Dr. Moon, won the admiration of those present.

Mr. Reichard, chairman of SMPTE's Laboratory Practice Committee, described the history and contents of the Society's new book, "Control Techniques in Film Processing."

Mr. Scales described the radio and television network activities of the Armed Forces Radio and Television Service. By means of short-wave radio broadcasts beamed to all parts of the world from stations on both the east and west coasts, U.S. service personnel hear news, sports and music programs. Additionally, there are many other AFRTS radio stations around the world which receive programming by means of 12-in. microgroove records containing 33 minutes of program material.

There are currently 39 key television stations which receive programming by 16mm film and kinescope recordings made from the lines of the three major networks. Most of this recording is done by AFRTS personnel who have achieved a high level of quality by careful attention to detail.

Mr. Sogge described both the "Safari" mobile sound-recording studio in a trailer and the small, transistorized "Nomad" recorder, both of which are unique in the motion-picture field. The "Safari" employs a conventional Magnasync recorder in a mobile, 3-wheeled trailer housing, which also contains a 4-position mixer, batteries, a d-c to a-c converter, and storage space for microphones, cables, etc. The "Nomad" recorder, designed basically for the advanced amateur, attaches to popular 16mm cameras and receives its transport power by means of a flexible cable from the camera. Transistorized electronic circuitry and a novel hand mixer enable the operator to achieve great flexibility in usage.—Ralph E. Lovell, *Secretary-Treasurer*, 2554 Prosser Ave., Los Angeles 64.

The New York Section met on December 14 at the World Affairs Center Auditorium with an attendance of 92. Participating in the 8mm Symposium were: John Flory, Advisor on Non-Theatrical Films, Eastman Kodak Co.; Arthur J. Miller, Vice-President, Du-Art Film Laboratories, Inc.; Everett Hall, Vice-President, Fred Watson Associates; and Raymond Hennessy, General Manager, Fairchild Camera & Instrument Co.

Mr. Flory, opening the symposium, presented an illustrated report on the present status of both 16mm and 8mm films. In commenting on the future of 8mm sound films, he noted that about 8,000,000 8mm projectors are now in use, as against 600,000 16mm projectors, with production running at a rate of 800,000 8mm units versus 50,000 16mm projectors per year. He stated that the goal of industry should be to get 8mm sound films into the "paper-back book" class as a tremendous force for the communication of knowledge.

Mr. Miller took up the question of laboratory problems in the production of 8mm films. Noting that it is the usual practice to use reversal films for production of 1 to 40 prints, he stated that for producing large numbers of prints, 100 to 1,000, multiple-width films such as 32mm (4–8-mm) or 35mm (4–8mm) would have to be used with specially prepared intermediate negatives. Mr. Miller felt that one of the most important factors in the production of quality 8mm sound films would be tighter tolerances on the part of both the film manufacturers and the processing laboratory.

The application of sound to 8mm films was discussed by Mr. Hall, who told of the several ways of applying the magnetic stripe to the film. He indicated that while an optical track has been produced he felt that the 8mm optical soundtrack was in the experimental laboratory stage and that magnetic sound reproduction was the answer.

Mr. Hennessy described the new Fairchild 8mm Sound Camera as a single-system amateur camera, motor driven at 24 frames/sec, battery powered, with a transistorized amplifier. He emphasized that the Fairchild camera was not intended as a professional tool, stating that the available 16mm equipment was better and more effective. An interesting note was that the Fairchild projector, developed and placed in production in less than a year, is designed to operate at 18 and 24 frames/sec since tests showed that 18 frames/sec was closer to the actual speed


TRI ART COLOR
THE ULTIMATE IN LABORATORY FACILITIES
BLACK AND WHITE
DU ART

of 16 frames/sec cameras. — James W. Kaylor, *Secretary-Treasurer*, c/o Movielab Film Labs., 619 West 54 St., New York 19.

The New York Section met on January 18 at the World Affairs Center Auditorium with an attendance of 105. Guest speakers were: Walter P. Siegmund, American Optical Co., whose subject was "Fibre Optics"; and William Vinten, W. Vinten Ltd., London, England, who discussed "Television in Europe."

A great deal of interest was expressed in Dr. Siegmund's presentation of a subject which is not too familiar to the general membership. This was demonstrated by the fact that he was requested to extend his talk beyond the prescribed time limit, which he did. Applications of fiber optics in industry and medicine were given adequate consideration.

Mr. Vinten was a last-minute addition to the program and was unfortunately compelled to make his presentation brief. Color slides showing British facilities were of interest to the gathering.

No discussion was possible due to the over-extension of the original time allotted. —William H. Metzger, *Secretary-Treasurer*, c/o Ansco, 405 Lexington Ave., New York, N.Y.

The San Francisco Section met on December 13 for its annual nonengineering meeting to which members may invite their families and friends.

After cocktails and dinner the group moved to the Rita Theatre for the meeting at which Arthur Miller, Past President of the American Society of Cinematographers, was the guest speaker. Mr. Miller, who started in motion pictures in 1908, working for some of the first film producing companies such as Pathé and Rex, talked about his experiences in photographing early films, among them the serial "The Perils of Pauline," starring Pearl White.

Three times Mr. Miller has been awarded the coveted Oscar for his outstanding work as director of photography. He has more than 150 pictures to his credit, among them "The Song of Bernadette" and "The Keys to the Kingdom."

"The Golden Age of Comedy," an entertaining picture loaned to the Section by the Valiant Film Corp., was shown after Mr. Miller's talk.—Frank Mansfield, *Secretary-Treasurer*, 57 Stoneyford Ave., San Francisco, Calif.

The San Francisco Section met on January 10 at KGO-TV Studios with an attendance of 56. Charles F. Swisher, Video Application Engineer, Ampex Corp., was the guest speaker. His subject was the British Broadcasting Corporation.

Mr. Swisher, who spent considerable time at the B.B.C.'s White City studios in England, presented an interesting and informative forty-minute talk, which was followed by a sixty-eight minute award-winning documentary film, "This is B.B.C.," which was enjoyed by the audience.

A business meeting, cocktails and dinner at the Rathskeller Restaurant preceded the meeting.—Clifton R. Skinner, *Secretary-Treasurer*, Skinner, Hirsch and Kaye, 336 Funston Ave., San Francisco, Calif.

The Washington, D.C., Section reports that an unbelievable series of circumstances made possible "The Welcome to Washington" presented October 11, 1960 to the Army Pictorial Service Conference, The High Speed Processing Symposium of the Society of Photographic Scientists and Engineers and the Fifth International Congress on High Speed Photography.

The Section was host for this event presented in cooperation with the Motion Picture Service of the United States Information Agency. The cooperation of the Department of Defense and the United States Marine Corps permitted the participation of the United States Marine Band and the Drum and Bugle Corps of Marine Corps Headquarters.

Including participants, five hundred people witnessed this special meeting which was described as one of the best section meetings ever.

Turner B. Shelton, Director of the Motion Picture Service, USIA, spoke on the subject "How Foreign Audiences View The American Heritage." It was illustrated with special film footage consisting of excerpts from many USIS films shown throughout the world. (In itself the footage could be used as a demonstration reel of the outputs of many film producers and examples of film processing by many laboratories.)

Mr. Shelton traced the history of the United States, the events in history and the

contributions of the early settlers and their backgrounds from which America has drawn much of its strength. It was continually emphasized that freedom means responsibility. More important than what the foreign audience is told is what they discover for themselves in the various USIS motion pictures.

At the conclusion of his presentation, heretofore seen only at the University Film Producers Association convention at Williamsburg, Virginia, and the Edinburgh Film Festival, Mr. Shelton told the audience: "No day goes by but that we give thanks to you motion picture and television engineers for the magnificent work which you have done over the years to make the motion picture the powerful, faithful and responsible instrument of communication it now is.

"I was most impressed by the high technical quality of the motion pictures we made on President Eisenhower's tours of Latin America and Asia. Only you could know all the technical demands required for the coverage of the President's travels in very different places with different facilities and varying climatic conditions at almost every stop. And you know the high skill and art it took to make this photography quickly into finished documentary films worthy of their distinguished subject.

"Heads of governments have said many significant things about motion pictures. They agree that the motion picture, the moving image, is the most important and effective medium of mass communication. A few leaders—like Lenin, Stalin and Khrushchev—use pictures as a means of mass agitation and for promoting what is called the cultural offensive. But many of us have seen in the motion picture the means for communicating concepts of truth and progress and liberty, and for extending a message of international good will and cooperation to billions of people, literate or not.

Turner B. Shelton, Director, Motion Picture Service, USIA, guest speaker at the Washington Section's "Welcome to Washington" meeting.

"The motion picture is a massive force in the world of today and tomorrow. You, the scientists and technicians, you engineers have brought about its development to its present high state. I know you will advance it even further in the future."

The meeting was held in the beautiful new auditorium in the Department of State. This was one of the first meetings in it and the first to be held in the evening.

Captain Dale Harpham, Assistant Director of the Marine Band, was responsible for the beautiful and inspiring musical presentation which was the first part of the program. A special unit of the band played popular music preceding the formal opening of the meeting.

Dr. Albert McCartney prayed for God's blessing on our country, its leaders, and our meetings.

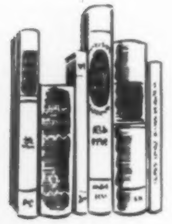
A Marine Color Guard and a 26-piece band presented the Colors and played the National Anthem.

Under the direction of Warrant Officer Chris Stergiou, the Drum and Bugle Corps staged one of their very few indoor appearances. Their showmanship and musical ability were enthusiastically enjoyed by the audience.

Sections Vice-President Garland Misener extended the Welcome to Washington on behalf of the Society, and Howland Pike, Chairman, extended it on behalf of the Washington, D.C., Section.

We are very grateful to the many people who helped and in particular to James Dunton, Department of Defense; Fernleigh "Red" Graninger and Charles Shinkwin, Department of State; General David M. Shoup, Commandant, and Lt. Col. W. L. Dick, A.D.C., The Marine Corps; Turner B. Shelton and Jack W. Evans, Motion Picture Service, USIA; and a special thanks to the Headquarters Staff of SMPTE for their splendid cooperation.—William E. Youngs, *Secretary-Treasurer*, 231 Mayflower Drive, McLean, Va.

Murray Neidich



books reviewed

Image Dissection in High Speed Photography

By J. S. Courtney-Pratt. Published (1958) in English by Verlag Dr. Othmar Helwich, Darmstadt, Germany. 11¾ by 8 in. 38 pp. incl. 111 Refs. Illus. Price $3.00.

The book has an excellent bibliography and it presents an updated review of image-dissection systems which have been used in high-speed motion picture photography. The author, Courtney-Pratt, is a recognized expert in this field. For the uninitiated he may have defined the term "image dissection" too briefly in the statement in the Abstract that "in (image dissection) the picture is divided up into a large number of small elements...... The elements are spaced out so that (in at least one dimension) each is separated from its neighbors by a distance that is large compared with the width of the element . ."

In an unpublished paper by the reviewer, it is stated: "The term 'image dissection' may be parochial and used by only a few experts. Dissected images have proved of value in at least three widely different photographic applications: first, in color photography; second, in stereoscopic photography; and third, in high-speed motion picture photography.

"The general public has had most intimate contact with image dissection in the field of color photography. If color separation images can be recorded and viewed through 'minute focal plane filters,' (then) in a single gross area additive red, green and blue images can be completely intermixed. A given 'point' in the 'scene' may be locally recorded as three adjacent 'points', red, green and blue. When viewed, these points in the recreated 'scene' will appear as single points having proper color because of admixture of red, green and blue light.

"Historically, colored screen plates and colored starch grain plates may well have been the first use of 'dissected images.' A significant innovation in image dissection for color photography was accomplished by optical means in the Berthon (later Keller-Dorian) process when lenticular embossings were used to produce 'minute focal plane filters.' A major advance in 'image dissection' methods of producing color pictures resulted from the introduction of the multilayer subtractive color processes which permitted $\hat{z}$ axis separation rather than $\hat{x}$ and $\hat{y}$ displacements of point images."

(This paper, incidentally, went on to recite the possibility that if one could illuminate a scene in rapid succession first with red, then green, and finally blue light one could produce an extremely high speed three-image-sequence motion picture with an ordinary color still camera.)

The Abstract of the Courtney-Pratt book correctly states:

"Image dissection cameras have been built that allow short series of good pictures at rates of 10^7 or 10^8 per second of remote objects and at or near unity magnification, or that allow cinemicrography at 10^6 pictures per second at magnification up to 2000 ×. Alternatively, long series of, say 10^5 pictures, of lower resolution are possible. Cameras to achieve these results use only inert optical elements and mechanical components. The use of the deflecting image converter in combination with dissection principles allows one to take short series, of about 50 pictures, of 100-line quality at rates approaching 10^9 per second.

"Spatial resolution and positional accuracy are discussed, and time resolution and stroboscopic effects. The advantages and disadvantages are described, and a number of illustrations presented."—*Fordyce Tuttle*, Eastman Kodak Co., Camera Works, 343 State St., Rochester 4, N.Y.

Electrical Noise

By William R. Bennett. Published (1960) by McGraw-Hill Book Co., 330 W. 42 St, New York 36. iii-viii + 280 pp. incl. illus. and diagrams. 6 by 9 in. Price $10.00

Noise is being recognized as a major problem in the arts relating to communication and perception. It is really only noise when audible, but current usage still calls it "noise" when it is in an electrical signal, or in a mechanical displacement, or in a television picture, or even in a temperature fluctuation. There is a fast-growing literature on the subject, and the present volume is a part of it.

The book, by a distinguished contributor to the field, particularly its mathematics, covers especially the noise in the electrical signal used in communications. Much of the material is applicable to other aspects of noise also. The work is an outgrowth of a series of articles in *Electronics* magazine.

The author analyzes the generation of noise in various parts of communications systems, i.e., thermal noise, noise in vacuum tubes and semiconductors, and noise in the radio medium. He discusses noise testing and the design of low-noise equipment, and gives mathematical treatments of noise engineering. The book ends with general studies of noise effects in specific communications systems. The treatment throughout is presented with carefully worked out mathematics so that it is as basic as possible and yet requires only a moderate knowledge of theoretical physics. Much of it is designed around response through a tuned circuit, and Fourier analysis is reserved for the last hundred pages.

Among the interesting points covered is a fairly extensive discussion of the signal-to-noise performance of a maser. This is not exactly elementary, but the author has gone to great pains to keep it within bounds in its demands on the reader. While the matter may not be of pressing importance to most engineers now, it will become so for long-range television links in the future.

The engineer who has to cope with noise might wish that the author had included the study of more possible sources. Specifically he has not considered noise from contacts, noise induced from paralleling facilities, from static and lightning, from mechanical working of copper conductors, etc. Also he has given but little space to impulse noise.

For engineers, the work is primarily for such of them who look for a fundamental treatment of noise and its properties, and how to design systems in view of it — all with sound but not too advanced mathematics.—*Pierre Mertz*, 66 Leamington St., Lido Beach, L.I., N.Y.

Focal Encyclopedia of Photography (Desk Edition)

Edited by Frederick Purves. Published (1960) by Focal Press, Ltd., 31 Fitzroy Square, London, W.1. U.S. Publisher, Macmillan Co., 60 Fifth Avenue, New York 11. 1298 pp. 5½ by 8½ in. Line-cut illus. Price $6.95.

The 1956–7 edition of the *Focal Encyclopedia of Photography* has now been brought out in a desk edition of reduced size. According to the jacket, only the photographs (and some introductory pages) have been omitted, and the format slightly reduced. But the full text and all the pictorial diagrams have been retained. The price is about one-third that of the larger edition.

The earlier edition has been hailed as a monumental work, and this holds for the desk form. An editorial board of 52 members, including consultants on 14 broad subject divisions, is listed. Other contributors bring the total (announced on the jacket) to 197.

Certainly the wide range of topics is extraordinary for a one-volume work. Emphasis is laid on the viewpoint of the practicing photographer — as indicated by a heavy preponderance of consultants on "Applied Photography" and "Camera Subjects" in the 14 subject divisions.

As a result, there are many interesting articles on such subjects as fashion, glamour, theater, freelance, commercial, portrait, child, animal, night, marine, cloud, documentary and cold-weather photography, and there are artistic discussions on perspective, composition, pictorialism, picture quality and judging, color impact, make-up, etc.

But there also is a detailed treatment of photographic history, covering many distinguished names in the field. Further there is extensive treatment of photo-

graphic exposure and processing, ranging from obsolete techniques to color materials. Except in a few cases, however, the discussion is not quite detailed enough to use as a guide in mixing chemicals nor are tables of film speeds given, and the list of flash bulbs has no identification by commercial code numbers.

There is a fairly extensive treatment of elementary optics, scattered among various specific subjects. These run to zoom (called in England "variable focus") lenses and Schmidt optics — but the discussion on such advanced topics is quite sketchy.

Some of the subjects that are really too ambitious are given summary presentations. Thus sound recording is given 2 pages; high-speed photography and cinematography, 5 pages; wide-screen and three-dimensional projection, 2½ pages; "vision," 2½ pages; "electricity" receives 1½ pages, largely confined to house supply and batteries and resistances; and "photography" 15 lines, on the history of the use of the term.

On "projection" (still and cinematographic), it is interesting to note that British ideas of "ideal" screen luminance for private houses in complete black-out, run from 1 to 2 foot lamberts; for daylight and average curtains, 2 to 5 footlamberts, and for cinemas, 9 to 15 footlamberts, the latter being more in accord with our own ideas.

A reader will of course always question the choice of specific items. One can wonder, with space at so high a premium, at the inclusion of such topics as switches, packing and sending photographs, insurance, reproduction fees, and trade in photographic goods.

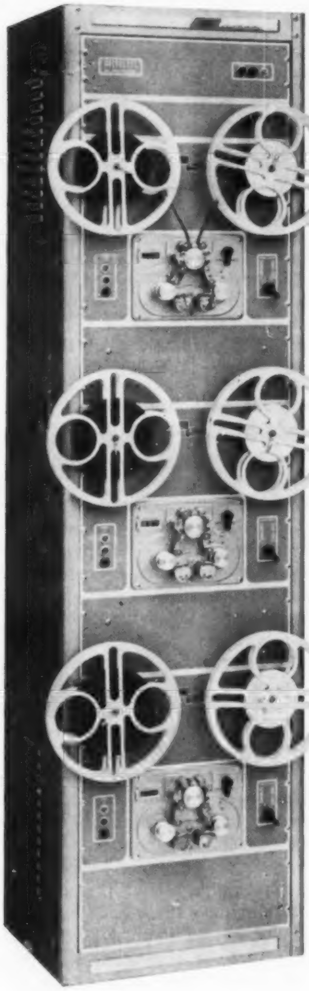
All in all, however, this should be an extremely handy book for general reference.—*Pierre Mertz*, 66 Leamington St., Lido Beach, L.I., N.Y.

Grundlagen der Breitwand-Filmverfahren

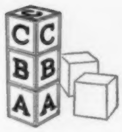
By Dr. E. M. Goldowski. Published (1959) by Fotokinoverlag Halle, Halle (Saale), Germany. (Translation of Russian original published Moscow 1956.) 6 by 8¼ in. 148 pp. 45 illus. 22 tables. Price DM 10.80.

This book was originally issued in Moscow, Russia, in 1956 and then translated into German for the present release in 1959. In the process, some of the timeliness of the contents has been lost. The book is, however, a good summarization of practical and historical wide-screen processes going as far back as 1895.

Film width systems discussed include both 35mm and 70mm. The author analyses objectively the overall merits of modern widescreen systems that have come to use since 1952. He goes into considerable detail on aspect ratios, optimum seating arrangements and good viewing conditions. He discusses the merits of curved screens, and renders a very interesting opinion on light distribution and its permissible falloff at the sides of the screen. A full chapter covers flicker and its perception with particular regard to wide screens and their correspondingly wide viewing angles. Numerous curves and tables enhance the text, and the mathematical treatment is

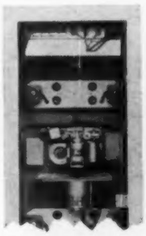


MAGNASYNC DUBBERS are SOUND ENGINEERS' "BUILDING BLOCKS"



Producers have found that the use of a single recording channel is only a small part of the tremendous savings possible with magnetic film recording. The next step for the organization seeking quality, economy and independence is to equip to handle their own transfer work, assembly and magnetic mixing of dialogue, music and sound effects.

Magnasync dubbers are of "modular" design and are available individually or in combination of two or three units mounted in an enclosed rack cabinet that requires only 22" of floor space.



Rear interior view of Selsyn motor electrical interlock

FEATURES:

- Plug-in preamplifiers with balanced 600 ohm output at zero vu.
- Individual synchronous drive motors.
- Torque motor take-up guarantees smooth film handling and hi-speed rewind.
- Electrical interlock assures absolute "sync" with projector from dead start.
- Wired for remote control, start and stop.
- Fast rewind, fast forward.
- Position for second playback head for transfer of both edge and center track recordings.
- Available with 16mm, 17½mm or 35mm transports.

GENERAL SPECIFICATIONS:

Frequency response: 50 cps to 8,000 cps, ± 2 db (16mm, 36 fpm), 50 cps to 12,000 cps, ±2 db (17½mm or 35 mm, 90 fpm).

Signal-to-noise ratio: $>$ 50 db.

Flutter and wow: 0.12% maximum RMS in any single band.

Distortion: $<$ 0.18% maximum RMS overall total harmonic.

from **$1280.**

Send for complete literature

MAGNASYNC CORPORATION

formerly Magnasync Manufacturing Co., Ltd.

Magnaphonic SOUND SYSTEM

5548 Satsuma Avenue, North Hollywood, California • TRiangle 7-0965 • Cable "MAGNASYNC"

International leaders in the design and manufacture of quality magnetic recording systems

Magnasync Studio Equipment Division Dealers:

CHICAGO: Zenith Cinema Service, Inc.; Behrend Cine Corp.; **LOS ANGELES:** Birns & Sawyer Cine Equipment; **NEW YORK:** Camera Equipment Co.; **SOUTH AFRICA:** Johannesburg, Photo Agencies Pty. Ltd.; **AUSTRALIA:** Sydney, New South Wales, Sixteen Millimetre Australia Pty. Ltd.; **BOLIVIA:** La Paz, Casa Kavlin; **BRAZIL:** Rio De Janeiro, Mesbla, S.A.; **BURMA:** Rangoon, G. K. Theatre Supply Co., Ltd.; **CANADA:** Toronto, Ontario, Alex L. Clark, Ltd.; **DENMARK:** Copenhagen, Kinovox Electric Corp.; **ENGLAND:** London, W-1, Delane Lea Processes, Ltd.; **FRANCE:** Paris, Brockless-Simplex S.A.; **GREECE:** Athens, Christos Axarlis; **HONGKONG:** Supreme Trading Co.; **INDIA:** Bombay, Kine Engineers; **ITALY:** Rome, Reportfilm, di J. M. Schuller, S.R.L.; **JAPAN:** Tokyo, J. Osawa & Co., Ltd.; **NEW ZEALAND:** Auckland, Kerridge Odeon Industries; **PAKISTAN:** Karachi 3, Film Factors Ltd.; **SOUTH RHODESIA:** Salisbury, William Over & Co. Pvt. Ltd.; **THAILAND:** Bangkok, G. Simon Radio Co., Ltd.

plain and clear. Recent advances in magnetic multichannel sound reproduction are briefly covered. The book closes with a description of panoramic projection, such as used in Cinerama.

A bibliography shows other sources of information, mostly of Russian, French, British and German origin.

The book offers thorough coverage of wide-screen film processes, much of the material being of a type not previously gathered under the general subject of wide screen. Of significant value is the fresh approach offered by the Eastern European origin of the material.—*Willy Borberg*, GPL Div., General Precision, Inc., Pleasantville, N.Y.

Eliminating Man-Made Interference

By Jack Darr. Published (1960) by Howard W. Sams & Co., 1720 E. 38 St., Indianapolis 6, Indiana, Paper-bound. 160 pp. illus. 5½ by 8½ in. Price $2.95.

This book is intended mainly as a guide to the service technician dealing with noise and interference problems in radios, television sets, electromechanical apparatus, etc., in tracing such interference to its source and then eliminating or subduing it. Many of the illustrations (173 in all) show the appearance on TV screens of the various types of interference that plague set owners. The book is divided into 12 chapters, including a chapter on Case Histories and another on the FCC and Its Role in Interference Complaints.

Nontheatrical Films — Interim Report No. 2

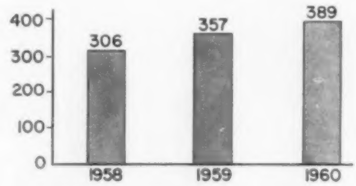
By JOHN FLORY and THOMAS W. HOPE

This Second Interim Report brings up to date (as of January 1, 1961) and amplifies selected statistics contained in the authors' comprehensive study of the nontheatrical field, "Scope and Nature of Nontheatrical Films in the United States" published in the June 1959 issue of the Journal *(pp. 387–392). It supersedes the Interim Report published in the January 1960 issue of the* Journal *(p. 70).*

ONCE AGAIN, an annual estimate of the U.S. nontheatrical film and audio-visual field shows significant growth. A $389 million expenditure for 1960 represents a 9% increase over the 1959 readjusted total of $357 million (Fig. 1).

The past year was noteworthy as the second year during which the full impact of the National Defense Education Act was felt. Increased concern with the aim of improving the scope and quality of the educational system was reflected in increased emphasis on educational film and related media.

This report has been prepared by John Flory, Advisor on Nontheatrical Films, and Thomas W. Hope, Assistant Advisor, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.



(In millions of dollars)

Fig. 1. U.S. audio-visual expenditures in 1960 reach $389,000,000.

Educational film and AV expenditures for 1960 were ahead of the previous year by more than 32% (Table I).

New Information Available

Newly acquired information has made it advisable to revise upwards the earlier statistics on dollar expenditures shown in last year's Interim Report.

New data are now available on three facets of the field—filmstrip projectors, university-produced educational films, and 16mm film library distribution. Accordingly, all of the Tables included in this report have been revised to give valid comparisons on an annual basis.

Sales of filmstrips for education and filmstrip projectors especially reflected the impetus given to newer educational media by the NDE Act (Table II).

Filmstrip producers and distributors throughout the country are reporting greatly increased filmstrip sales during the past twelve months. Unit sales of filmstrip projectors were up 59% during the same period.

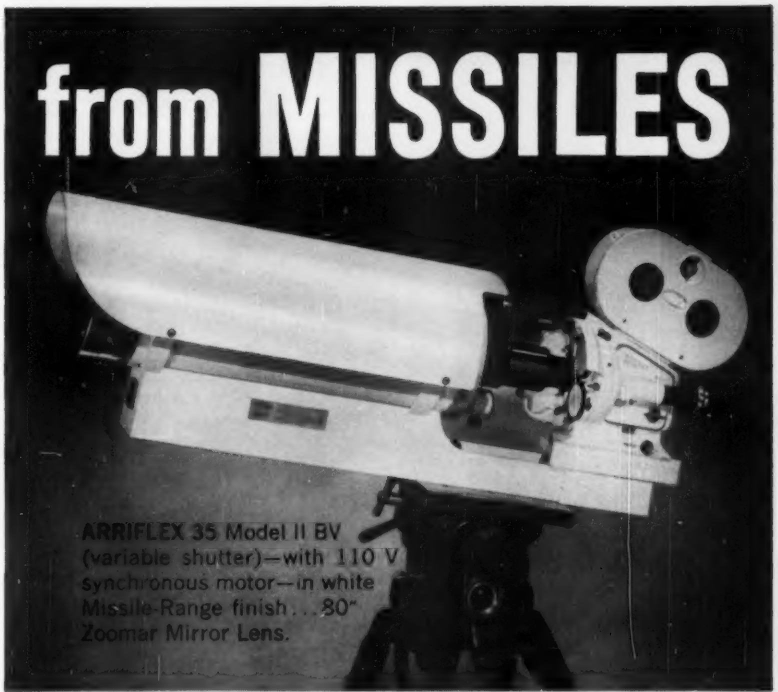
Preliminary findings of a study being conducted for the U.S. Office of Education by the University Film Foundation indicate that today nearly 100 universities, colleges and public school systems in large cities are regularly engaged in producing motion pictures. Based on these preliminary returns, it is estimated that the total annual educational output of these nonprofit institutions is considerably greater than heretofore generally realized.

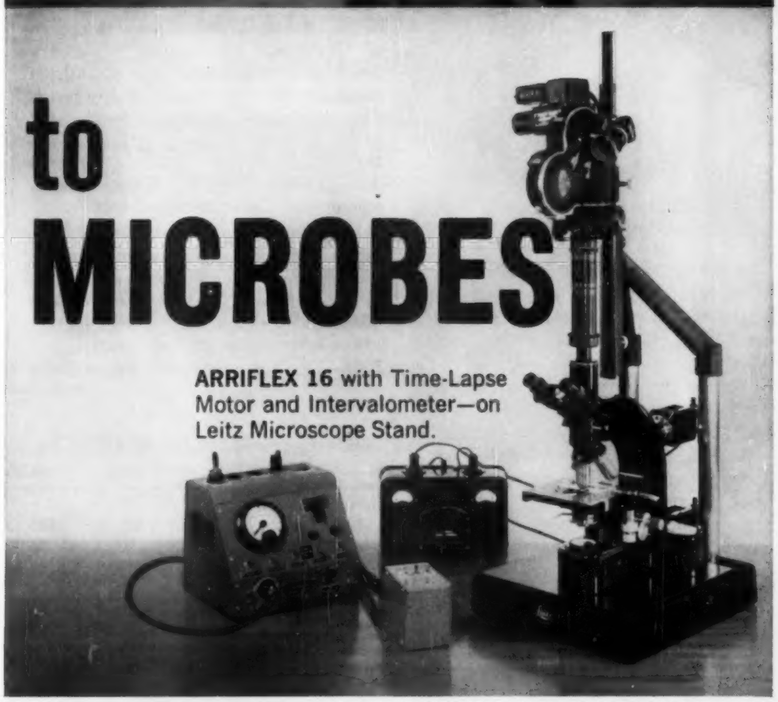
The third major factor in the revision of previously evaluated total expenditures is in the area of film distribution. An analysis of the latest U.S. Office of Education directory of 16mm libraries* reveals that educational institutions and business organizations operate more than half of the libraries (Table III).

Although this government study lists 3660 film libraries, a figure of 5000 would today probably be a more accurate estimate. This would take into consideration normal growth of the field, in addition to hundreds of libraries asking to be excluded from a national directory because they are obliged to restrict service to users within their own school systems.

* U.S. Office of Education, "A Directory of 3660 16mm Film Libraries," Supt. of Documents, Washington 25, D.C., 1958.

no other camera does the job like





ARRIFLEX®!

for complete literature, write
ARRIFLEX CORPORATION OF AMERICA
257 PARK AVENUE SOUTH, N.Y. 10, N.Y.

ARRIFLEX CORPORATION OF AMERICA
257-K PARK AVE. SOUTH, NEW YORK 10, N. Y.

Without obligation, I would like:
☐ DEMONSTRATION ☐ LITERATURE
☐ on ARRIFLEX 16 ☐ on ARRIFLEX 35

name ....
company ....
address ....
....
city .... zone .... state

Table I. Who Spends AV Money? A Three-Year Comparison (in millions).

	1958r	1959r	1960	1960 vs. 1959
Business and Industry	$155	$178	$184	+3.4%
Education	55	78	103	+32%
Government	56	59	59	no change
Religion	19	19	18	−5.2%
Civic, Social Welfare, Recreation, etc.	14	15	16	+6.7%
Medical	7	8	8	no change
Totals	$306	$357	$389	+9%

r = revised Jan., 1961.

Probably over 19,000 persons are employed by the estimated 5000 nontheatrical film libraries. The figures for distribution expenditures, in this Second Interim Report, now take into account the salaries of these persons (see column labeled "Distribution" in Table IV).

Accordingly, 1958 and 1959 estimates for total film distribution expenditures have been revised upwards. Thus 1958 was raised from $38 million to $78 million, and 1959 from $42 million to $85 million (Table V).

Type of Information Analyzed

Table IV gives the detailed analysis of 1960 for the principal basic categories of "Business," "Education," "Government" and "Religion." The specialized category of "Medicine" encompasses data that would otherwise be allocated to the fields of "Business," "Education" and "Government." Medical expenditures, therefore, are not duplicated elsewhere.

It is hoped that in future years, detailed statistical information can be compiled for other specialized fields, such as "Agriculture" and "Home Entertainment."

Table II. U.S. Filmstrip Projector Sales (units estimated).

	Unit sales	Percentage increase
1958	120,000*	—
1959	131,400	10%
1960	210,000	59%

* Based on 1958 U.S. Census of Manufacturers.

Table III. Nontheatrical Film Libraries (Est.) for 1958.

Educational	1400
Business and Industrial	1150
Governmental	560
Commercial Dealers	550
Civic, Social Welfare, etc.	500
Medical	440
Religious	400
Total	5000

Numerous questions have been asked as to what data are included within each of the five major types of expenditures. They are:

Production — motion pictures, filmstrips, and sound slidefilms

Table IV. Estimated 1960 Expenditure Factors by Categories (in millions).

	Production	Release prints	Distribution	Mot.-pic. equipment	Other AV	Total	Percentage change from 1959
Business and Industry	$ 73.8	$38.6	$35.0	$ 7.5	$29.1	$184	+3.4%
Education	14.0	9.7	26.3	19.8	33.2	103	+32.1%
Government	19.3	9.4	13.6	3.2	13.5	59	no change
Religion	3.4	2.8	6.7	2.6	2.5	18	−5.2%
Civic, etc.	1.5	1.5	10.1	1.9	1.0	16	+6.7%
Medical	3.0	2.0	1.3	1.0	0.7	8	no change
Totals	$115	$64	$93	$36	$80	$389	+8.9%

Table V. How the Money Is Spent: Estimated Nontheatrical Film and Audio-Visual Expenditures by Type of Product (in millions).

	1958r	1959r	1960	1960 vs 1959
Production	$100	$115	$115	no change
Release Prints	49	57	64	+12.3%
Distribution	78	85	93	+9.4%
Motion-Picture Equipment	29	32	36	+12.5%
Other Audio-Visual	50	68	80	+17.4%
Totals	$306	$357	$389	+9%

r = revised Jan., 1961.

Release prints — motion pictures, filmstrips, and sound slidefilms

Distribution — commercial and audio-visual dealer film rentals and sales; sponsored film distribution; and school, governmental, religious, medical, social service and public libraries.

Motion-picture equipment — 16mm sound projectors, cameras, and production equipment such as lights, sound recorders, etc.

Other audio-visual equipment and materials — sound slidefilm, filmstrip, 2 × 2-in. slide, 3¼ × 4-in. slide, overhead and opaque projectors; projection screens; projection stands; materials for making slides and overhead transparencies; and a great number of other sundry items.

Film Production and Projectors

Motion-picture production dropped off slightly in 1960 (Table VI) while filmstrip production increased, according to reports. The dollar expenditure for all production, however, stayed about even (Table V).

Sales of 16mm sound projectors rose considerably compared to the previous year. Although it may be several months before final figures are available, preliminary reports indicate that total sales for 1960 were approximately 50,000 of which 45,000 were for the domestic market. The purchases, by major categories, show that America's schools absorbed 60% to 65% of the new p o-jectors.

This year for the first time an estimate of the number of 16mm sound projectors in use in the home has been included in the total for the United States (Table VII).

Taken into account in determining the year's increase in the number of projectors in use (net gain) are those machines which have worn out or otherwise become obsolete. In addition, the factor of second-hand projectors is included — primarily in the areas of "Religion" and "Home." It is estimated that there are 727,000 16mm sound projectors in use as of January 1, 1961.

Considering the entire population of the United States, there is now one projector for every 250 persons.

While the percentage of projectors going to schools increased in 1960, obviously due in part to the NDE Act, the ratio of buying by different kinds of schools remained about the same as in 1959, except that public secondary schools purchased 4% more than the year before (Table VIII).

A new development appeared during the year in the form of the 8mm sound projector. It is too early to include any data on it in this report.

More Data Needed

It is felt that to appraise the audio-visual field more accurately in future

Table VI. Estimated Number of U.S. Nontheatrical Motion-Picture Productions.

	1958r	1959r	1960
Business and Industry	4500	5400	5000
Education	1300	1500	1600
Government	1500	1500	1500
Religion	200	220	190
Civic, Social Welfare, etc.	200	210	210
Medical	300	400	300
Experimental	100	110	100
Totals	8100	9340	8900

r = revised Jan., 1961.

Table VII. Ownership of 16mm Sound Projectors in Use in U.S. (Estimated as of January 1, 1961).

Education	220,000
Business and Industry	179,000
Religion	127,000
Government	75,000
Home	65,000
Civic, Social Welfare, etc.	50,000
Medical	11,000
Total in Use	727,000

1961 Domestic sales — 45,000 (est.)
1961 Export sales — 5,500 (est.)
Second-hand machines resold — 13,500 (est.)
Projectors, assumed obsolete and therefore deducted — 15,000 (est.)

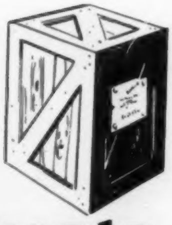
Table VIII. Projector Ownership by Schools (as of January 1, 1961).

	Projectors in use
Public Elementary Schools	118,000
Public Secondary Schools	68,000
Colleges and Universities	17,600
Private and Parochial Elementary and Secondary Schools	16,400
Total	220,000

years, capital expenditures — where not already considered as a part of production — should be included in this report. For example, in recent years considerable amounts have been spent by institutions and companies for the building and installation of conference rooms, classrooms and small theaters for the projection of films and other visuals

To complete the picture, attention should also be given to television, including closed-circuit and other forms of noncommercial usage, and audio activities in the field. Tape recorders, phonographs and public address systems in industrial and educational applications should also be included.

The authors welcome all information which can make these reports more accurate, and invite readers to give whatever assistance may help.



new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

Erratum: New Products, Oct. 1960, p. 780 — A new high-vacuum tube, type WX-4047, Westinghouse Electric Corp., Electronic Tube Div. Line 6 refers to the tube as "the Astracon image amplifier." This is incorrect. The Astracon is (as also stated in the item) the subject of a paper, "The Astracon Tube and Its Application to High-Speed Photography," by A. E. Anderson and G. W. Goetze, which was presented at the 5th International Congress on High-Speed Photography, but the Astracon and the WX-4047 are two different tubes. Both tubes were recently developed by the Electron Tube Division of Westinghouse Electric Corp. Except for the misnomer in Line 6, and the reference to the 5th Congress paper, the item describes the WX-4047.

Tiros II, the successor to the weather-watching satellite, Tiros I (*Jour*, pp. 272–273, Apr. 1960), has been designed to incorporate a new orientation-control system and newly-developed infrared instruments to measure the emission and reflection of solar heat by the Earth and its atmosphere. These improvements were developed following study of the behavior of Tiros I. Both satellites were developed by the Astro-Electronics Div. of the Radio Corp. of America for the National Aeronautics and Space Administration.

Behavior of the busy little Tiros I, faithfully sending cloud pictures (nearly 23,000 of them) to Earth during its three months life in Space, varied in certain significant ways from that predicted for it when it was first tossed into Space. Most noticeable mannerism was its tilt as it gradually leaned away from the predicted position of its axis. This phenomenon was found to occur under the influence of the magnetic field surrounding the Earth.

In Tiros II the magnetic forces are harnessed by generating a controllable magnetic field around the satellite by a coil of wires circling it. Interacting with the Earth's magnetic field, this device may be compared to an invisible hand which observers on the ground can use to tilt the satellite in the right direction to achieve a more advantageous angle for the sensors and the solar power supply. The infrared package, developed by NASA, includes a five-channel detector to measure selected portions of the infrared spectrum around the Earth. Tiros II weighs only 280 lb. Associated with the cameras are two specially-designed RCA tape recorders to store the TV pictures until the "readout" command is given from a ground station.

Membership Certificates (Active and Associate members only). Attractive hand-engrossed certificates, suitable for framing for display in offices or homes, may be obtained by writing to Society headquarters, at 55 West 42d St., New York 36, Price: $2.50.

An underwater vehicle equipped with four TV cameras has been given the nickname of RUM, a designation which carries no implication of liquid spirits but is short for "remote underwater vehicle." The vehicle, constructed by the Office of Naval Research, was developed by the University of California's Marine Physical Laboratory of the Scripps Institution of Oceanography. Crawling along the ocean's floor at a rate of three miles an hour at depths down to 20,000 ft, RUM is equipped with a mechanical arm ending in a monstrous claw that can clutch and raise marine specimens weighing as much as 1500 lb. The "eyes" of this man-made monster — which can remain submerged for months — are four vidicons (RCA-7038, 6¼ in. long and 1 in. in diameter) and associated camera equipment.

The cameras are housed in a steel case constructed to withstand the terrible pressure at the bottom of the sea. Mercury vapor lamps, also enclosed in pressure cases, illuminate the dark underwater scenes for a distance of about 30 ft. Signals from the cameras, designed by Orbitram Co., of Lakeside, Calif., are relayed to a monitoring and control station on land via a five-mile length of lightweight coaxial cable. Each camera is equipped with two remotely-controlled motors for adjustment of iris and focus.

Reports from Eastman Kodak Co. on new translating machines indicate that the astonishing storage potential of contemporary photographic techniques has extended almost beyond imaginable limits the possibilities of translating machines in terms of speed and accuracy. A machine currently in use by the Air Force translates from Russian to English at the rate of 40 words per minute, using special glass discs coated by Eastman Kodak with high-resolution photographic emulsion. A 55,000-word vocabulary is stored in a ¾-in. channel printed on a 10-in. glass disc, but modifications of the machine will permit it to translate more than 2400 words per minute from a vocabulary of about 500,000 words stored on the disc. Even the half-million-word vocabulary barely scratches the surface of photography's information storage capacity, according to Kodak scientists. In translating, the storage channel is scanned vertically and horizontally by electronics until

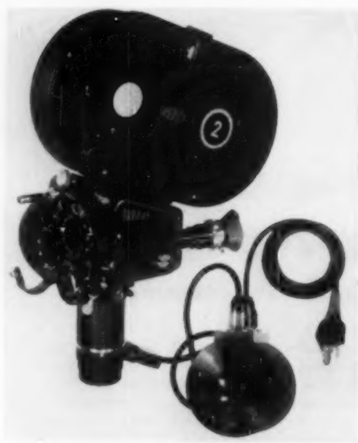
the machine matches a Russian word — fed in with punched tape — to its English equivalent, which is then printed automatically on a typewriter.

It has also been stated by Kodak research personnel that a high-resolution film, exposed with present optics, is capable of storing 600 million bits of information per square inch. For example, the entire contents of the *Encyclopedia Britannica* could be stored on a piece of film only four inches square.

A video band recorder/reproducer, an addition to 3-M's CM-100 series, has been introduced by Minicom Division, Minnesota Mining and Manufacturing Co., 2049 S. Barrington Ave., Los Angeles 25, Calif. Designated the CM-114, it records and reproduces 14 tracks of both analog and pulse signals on 1-in. magnetic tape. Frequency response on each track is 400 cycles to 1.0 mc at 120 in./sec. The machine has a selection of six tape speeds ranging from 7½ to 120 in./sec and features higher frequency response at lower tape speeds. It is designed to incorporate both a receiver and a scope if desired for predetection recording as a possible application. This type of recording may be used in missile operations where a flight is simulated by feeding the original data back to the receiver in the missile, and a checkout criterion provided for a recording ground station.

A video recording system available with either 16mm or 35mm camera for synchronized sound recording on film or magnetic tape is described in a 4-page illustrated brochure available upon request from GPL Division, General Precision, Inc., 63 Bedford Rd., Pleasantville, N.Y. Described as producing "professional quality interlaced film," it is recommended by the manufacturer for production on 16mm films for advertising agency previews, client or sponsor presentation and classroom projection. New features of the system are spot wobble, to provide smoother picture texture, and an alternate synchronizing generator to minimize synchronization irregularity of signals from varying sources.

A new model of the Arriflex 35, designed especially for instrumentation and documentation uses, has been announced by Arriflex Corp. of America, 257 Park Ave. South, New York 10. Designated the Arriflex 35-IIB-S, the camera is equipped with a balanced movement and a 32-v d-c motor for operation to 80 frames/sec. The motor is equipped with an external rheostat for speed control, with a circuit designed to maintain high torque at lower speeds. Equipment includes a tachometer calibrated to 80 frames/sec. The camera is priced at $1995 with special motor and speed control, but without lenses and magazines.



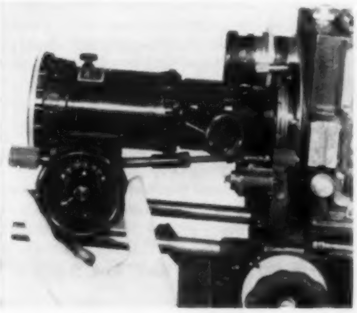
Arriflex has also announced a transistorized, governor-controlled motor for the Arriflex 35 designed so that only a relatively small current passes across the centrifugal switch of the governor mechanism, the heavy main current being controlled by the transistor. Designated the 9A773-T, it is priced at $190. A new 24–28-v d-c Variable Speed Motor, 9A744, is designed to drive the Arriflex 35 at frame rates ranging from 12 to 36 frames/sec. Priced at $160, it is expected to be useful in military and industrial applications.

The CECO Vari Speed Motor Base, No. 75400, for the Arriflex 35 mm Vari Speed Motor is a product of Camera Equipment Co., 315 W. 43 St., New York 36. The new motor base is designed to locate the motor in an upright position adjacent to the camera, this permitting base mounting without the use of a Hi-Hat. This arrangement is planned to lower the center of gravity by bringing the camera closer to the tilt pivot point of the tripod, thus creating a favorable condition for steadier tilting performance. The motor base is priced at $300.

The backward curving field of the new Super-Farron Lens enables their use as flat-to-flat, flat-to-convex or convex-to-convex imaging systems. Used in this manner the system is said to have an effective efficiency of T/0.5. The lens is produced by Farrand Optical Co., Bronx Blvd. & E. 238 St., New York 70. The abbreviated story in the June 1960 *Journal* (p. 460) illustrated a 1:1 relay system

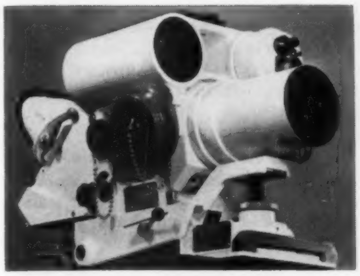
comprising two of the lenses imaging a flat field to a backward curving field.

A miniaturized wide-angle lens with a 180° field of view, called the Traid 735 Periphoto, has been designed and manufactured by Pacific Optical Co. for Traid Corp., 17136 Ventura Blvd., Encino, Calif., especially for use in drone scoring systems. The lens measures 1¾ in. and weighs 5¼ oz. Other specifications include equivalent focal length, 6.51mm; relative aperture, *f*/6.3, fixed; flange focus distance, 1.500 in.; 180° field of view; resolution of 80 lines/mm on axis; color corrected for Daylight Kodachrome; fixed focus, 60 in. to infinity; 67% distortion at 75°, 23% at 45°; round image, 0.720 in. in diameter. The lens is priced at $885.



A 38–154 Zoom Lens Attachment, designed to support the weight of the lens, has been announced by Camera Service Center, 333 W. 52 St., New York 19. Features include two knob controls to adjust the North-South, East-West movement of the lens, thus accomplishing accurate line-up of the crossline in the lens reticle with the crossline in the camera. A large knob controls the zoom action to increase zoom smoothness. This knob contains a built-in focal length stop and lock-off to permit the operator to select the desired amount of zoom. A driveshaft to simplify follow-focus runs from the camera control to the follow-focus gear located on the front of the lens. The attachment is priced at $480. (In addition to the manufacture of special motion-picture equipment, this firm has recently enlarged its rental facilities and added a sales department.)

A high-speed stereo-camera and projection system is being designed by Benson-Lehner Corp. for the Naval Weapons Laboratory, Dahlgren, Va., under an $83,000 contract. Delivery is scheduled for March, 1961. Combining high-speed photography with stereo photography, the new camera is designed for speeds of more than 12,000 frames/sec, arriving at full sync speed within 100 ft of film. Also provided is a means for varying the interaxial distance between the taking lens, so that the degree of stereo desired can be selected for the distance of a given subject. Interaxial baseline can be varied from 13 in. to 4 ft, providing stereo from 15 ft to infinity. Providing a three-dimensional record, the new system is expected to have important applications in many areas of research.



A Sighting Telescope, Model WS-10, with Mounting Compound and Acquisition Aid has been announced by Wollensak Optical Co., Rochester, N.Y. The telescope, a monocular refracting-type, employs interchangeable eyepieces of 10-power or 20-power which mount at a 45° angle to the main objective axis. The Acquisition Aid is designed to provide visual superposition of the area under surveillance with a radarscope display. A cushioned headrest is provided for the proper head position of the operator relative to the eyepiece. Hinged port covers at the sides of the headrest open to expose the diopter scale of the eyepiece for focusing. A replaceable reticle is provided with variable-intensity illuminations for night operation. The telescope is designed for use under extreme climatic conditions while withstanding the effect of vibrations created by power-driven tracking mounts. The body of the telescope is sealed against moisture and is provided with a chamber for the mounting of two silica gel desiccant cartridges of the screw-in type. The exterior is finished in white enamel to minimize the rise of internal temperature in direct sunlight. The telescope is presently being supplied to the Armed Forces and missile manufacturers for tracking objects in flight, boresighting, industrial aligning and measuring.

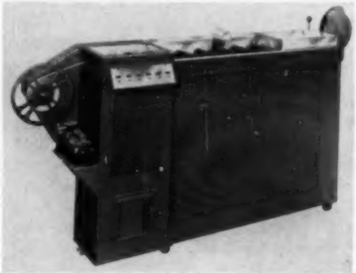
A line of time-resolved spectrographs is undergoing advanced prototype testing in the Instrument Division, Beckman & Whitley, Inc., 993 E. San Carlos Ave., San Carlos, Calif. The instruments are expected to permit temperature measurements in the 2000—20,000-K region, of events resolved in time up to 3×10^{-8} sec, and with wavelength distribution through the 2000—9000-A range. Photographic recording could be made of events in these classes by coupling a Beckman & Whitely sweeping-image camera to one of the spectrograph instruments. These spectrographs are expected to be primarily useful in the measurement and analysis of high-speed radiated transients, in work on the composition of molecular species, or in the investigation of concentration temperatures.

Automated and miniaturized motion-picture projection equipment has been developed by Reevesound Co., a subsidiary of Reeves Soundcraft Corp., for Inflight

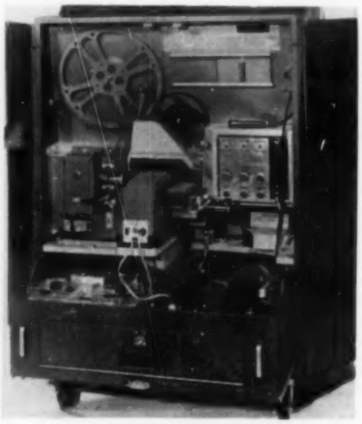
Motion Pictures, Inc., of New York, for showing previews of feature films on transcontinental flights. The idea is being tested by Trans-World Airlines. The projection equipment is said to be capable of showing up to 135 minutes of 16mm film from a single reel.

The Protect-O-Film processing machine for cleaning and applying antistatic protective coating to 16mm motion-picture film is a product of Harwald Co., 1245 Chicago Ave., Evanston, Ill. The firm has also announced new features on the Inspect-O-Film Model "U" machine. The processing machine treats the film by applying a cleaning-processing fluid by means of tapes moving in the direction opposite to that of the film. The fluid flow is electronically controlled. The machine is priced at $995. The Model "U" is used in the inspection, editing and cleaning of film. It has been improved by a new speed control and braking system, involving three motors controlled by direct current.

A method of identifying and sealing strips for developed 16mm film, developed by Goeffrey H. Botton, Manager of Machine Accounting, General Film Laboratories, Hollywood, eliminates the necessity for handwritten identification. With the new system, the firm's Order Department uses a "Request for Labels" form, showing title, quantity, etc., which is sent to the Machine Accounting Department. Here the cards are punched, and pin-feed, pressure-sensitive labels are imprinted on the IBM 407. The film reel label is then applied to the leader strip and the film is sealed until ready for projection.



The Allen 16mm Reversal Processor Model 700 is manufactured by Allen Products Inc. and distributed by S.O.S Cinema Supply Corp., 602 W. 52 St., New York 19. The newly announced machine is designed for processing 16mm reversal film and is convertible for negative or positive. Features include daylight loading of 1200-ft reels, variable-speed drive, bottom tank drains and plumbing with back-flushing system, refrigeration and recirculation. The film passes through nine tanks and drybox, all positions in-line, at speeds up to 20 ft/min. The machine is priced at $2995.



The Bi-Fi, a rear-projection console housing several equipments that can be operated individually or in combination, has been announced by Friddel Manufacturing Co., P.O. Box 721, Galveston, Tex. Designed for educational and industrial uses, it features a single control panel for "fool-proof" operation, and a 36-in. TV screen. Contained in the console are: the "Exhibitor" (No. 600) equipped with a 16mm projector for a conventional or for a six-minute continuous repeat program. It also incorporates a preamplifier and tape deck, with a programmer built into the amplifier for adding impulse to tape along with audio for the 40-slide repeater projector (45-w); the "Workhorse" (No. 100) with a 16 mm projector, 35mm filmstrip projector, 26-slide changer with automatic or remote control (25-w); the "Audio-Visual Center" (No. 500), equipped with 16mm projector, 35mm filmstrip projector, 36-slide changer (automatic or remote), turntable, preamplifier and tape deck, microphone and programmer (25-w); and the "Linguist" (No. 601) for teaching languages, equipped with projector for 35mm filmstrips and for 2 by 2-in. slides, automatic or remote control, preamplifier and tape deck, four-speed turntable, microphone and programmer (12-w). An Induction Wireless Receiver (No. 700) may be used in a classroom at the students' desks for the reception of audio. The receiver is equipped with amplifier and microphone. The console is 60 in. high, 25½ in. deep, and 32¾ in wide. It operates on 110–120 v, 60 cycles a-c.

employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Motion Picture Lab Manager and Color Process Engineer. Wide film manufacturing plant experience and subsequent field experience in setting up and operating color processing labs in the East and process development. Familiar with quality control procedures, chemical analysis, sensitometry of films, color print timing, color printing, duplicating and related optics. Also practical knowledge of the cinematographic arts and lab-shooting-company relations. Qualified also to set up and manage industrial department of photography. Several patents. College Grad. Desires West-Coast location. Reply Box No. 691, Hollywood, Calif.

Photo Coordinator Motion-Picture Cameraman. Experienced in most phases of instrumentation, data gathering and motion-picture production photography. Married, 29 yrs old, will relocate. Active member of SMPTE. Resume on request. Marvin Atwell McCoy, 3708 N. 23rd St., Arlington 7, Va.

Film and AV Executive. Presently Audio Visual Manager for major corporation. Extensive overseas experience writing, directing and producing educational, documentary, public relation films. Experienced in almost all fields of film production and AV media preparation and production. Seeking position with challenge and future. Age 36, Married, M.A. in Cinema. Write: John H. Humphrey, 72-10 41st Ave., Jackson Hts. 77, N.Y.

Cameraman-Director. Available for forthcoming Confederate Centennial assignments throughout the entire central and deep south. Located near actual battlefields and areas where Centennial will be staged. Also available for assignments to Smoky Mts., Blue Ridge Mts., Cumberlands, Mississippi Delta and Okefenokee areas. Twenty years experience in high budget documentary film production. John O. Evans, 2313-B Starmount Cir., S.W., Huntsville, Ala.

Engineer-Administrator. Have designed, set up and managed motion-picture laboratories in color and black-and-white. Familiar with full range of operations and equipment in a laboratory. Graduate M.I.T.: M.S. in Chemical Engineering, B.S. in Business and Engineering Administration. Several languages. Desire challenging position. Apt. 2J, 130 Orient Way, Rutherford, N.J. WEbster 3-3238.

Positions Available

Cameraman. Experienced 35mm color filmstrip cameraman. Salary open. **Printer for 35mm Color Film.** Experienced on Bell & Howell continuous loop printer or step printer. Salary open. Send resume to W. Jones, 234 West 13 St., New York 11.

Technician. Experienced technician to be assistant to chief engineer. No papers or degrees needed. Must be conversant with both radio and television and willing to supervise and train junior technicians. Contact Conrad Lavigne, CFCL Box 620, Timmins, Ont., Canada.

Color Negative Printer Control Man. Photographic background, with color printing experience. Flexible hours. Paid benefits. New York City. CIrcle 6–5606. Mrs. Goldenberg.

Representative. Graduate student working towards doctorate in Educational Television, receiving M.A. in motion pictures June 1961, B.A. in theater television, will be touring Latin America covering 64 cities in 20 countries and contacting over 100 television stations and 200 producers of newsreel, documentary, educational, television and feature films. Tour will be repeated each summer for three years. Also background three yrs electrical engineering and four yrs sales. Will represent your company and translate brochures into Spanish or Portuguese. Don Stewart, 2005 Sixth St., Santa Monica, Calif. EX 9-6795

Equipment Maintenance Men. Experienced in service and repair of one or more of the following types of equipment: Moviolas, sound projectors, Mitchell, Bell & Howell and Arriflex cameras, lens testing and calibration, audio and electronics for magnetic recorders and amplifiers, lighting and electrical equipment, machine shop. Write fully—experience and salary required. A. Florman, Florman & Babb, 68 West 45 St., New York 36.

Journals Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

Transactions 6 and 9 ($15 each offered). W. W. Hennessey, RFD #2, Pound Ridge, N.Y.

Jan. 1938, Jan. 1949. (Many other issues are available for trade.) Dept. of Cinema, Univ. of Southern Calif., University Park, Los Angeles 7. Att: Herbert E. Farmer.

Transactions No. 1, 1916 ($5 offered); No. 6, 1918 ($10 offered); No. 7, 1918 ($10 offered). James G. Barrick, 15726 Fernway Ave., N.W., Cleveland 11, Ohio.

Mar. 1939, May 1940, July, Feb. 1942, July 1949. V. E. Patterson, 2 North 30th St., Phoenix, Ariz.

Résumés / Resumenes / Zusammenfassungen

Certains aspects philosophiques des techniques photographiques à grande vitesse

Morton Sultanoff [1]

L'auteur examine les éléments d'incertitude dans l'interprétation des enregistrements photographiques obtenus par un grand nombre des techniques mises en jeu dans l'emploi des instruments photographiques à grande vitesse. La nécessité d'une compréhension nette des processus étudiés en termes de physique est indiquée comme une condition essentielle dans l'analyse et dans l'association du débit lumineux enregistré électriquement avec le processus en cause.

L'auteur décrit les difficultés qui se présentent dans l'analyse des enregistrements à stries obtenus avec la caméra à miroir tournant et recommande l'emploi simultané d'un équipement auxiliaire pour surmonter ces difficultés. Il démontre aussi l'importance d'un "conditionnement mental" pour éviter les dangers d'une fausse interprétation des enregistrements photographiques à grande vitesse. La nature des caméras utilisées, la lumière enregistrée et les caractéristiques physiques des processus étudiés doivent être analysés avec soin pour éviter les erreurs d'interprétation courantes, dont plusieurs sont illustrées dans le présent mémoire.

Le "pontage de l'arc" dans les lampes éclair au xénon

Harold E. Edgerton et David Cahlander [7]

Quand on exige d'une lampe-éclair qu'elle flamboie à de hautes fréquences, il est nécessaire que le circuit de charge fournisse davantage de courant. Eventuellement, il peut arriver un moment ou la lampe-éclair ne désionise plus, mais forme un arc continu; cet incident est connu sous le nom de "pontage de l'arc." Les auteurs indiquent les conditions pour la fréquence limitatrice en fonction des caractéristiques volts-ampères du circuit et des lampes. L'article présente aussi des données expérimentales sur plusieurs lampes-éclair. Une description est donnée des circuits qui forcent une lampe-éclair à fonctionner à haute fréquence même si elle ne désionise pas.

Les applications de la radiographie à flash

J. S. McVeagh [10]

L'auteur explique le fonctionnement de tubes-éclair à rayons X du type à trois électrodes et vide poussé, en insistant particulièrement sur l'emploi de ces tubes dans le type de circuit dit à bas voltage. On signale que ces tubes peuvent émettre des pulsations de rayons X qui sont très courtes en comparaison du "temps d'oscillation" du circuit électrique associé.

Une théorie est avancée pour expliquer cette particularité, ainsi que les autres caractéristiques de ces tubes. Cette théorie admet en postulat la production d'un jet de plasma qui est "pompé" de l'arc déclencheur vers l'anode par le moyen de l'effet de pincement électromagnétique. Le temps d'exposition aux rayons X correspond à la durée de passage de ce jet. La théorie soutient aussi qu'il doit y avoir un retard initial après la rupture de l'arc déclencheur avant qu'il n'y ait aucune élévation sensible d'intensité de courant dans le tube. L'auteur présente quelques preuves sur ce point, ainsi qu'un certain nombre de clichés radiographiques illustrant les applications de la technique au flash.

Radiocinématographie-éclair à des cadences allant jusqu'à 12.000 images/s

A. Stenzel et G. Thomer [18]

Poursuivant les essais présentés au dernier Congrès (Cologne 1958) les Auteurs ont étudié les conditions nécessaires à l'augmentation de la fréquence des décharges périodiques dans un tube de rayons X-éclairs. L'ancien montage, dans lequel le retour de la tension anodique était déterminé par un circuit R-C ou R-L-C et le déclenchement des éclairs assuré uniquement par des impulsions sur l'électrode d'amorçage, permettait d'atteindre au plus une fréquence de 5.000/s. En vue d'augmenter la cadence il est nécessaire que la tension anodique reste coupée complètement entre deux décharges.

Dans le nouveau montage la séparation périodique de la capacité de décharge et du tube est realisée par un éclateur d'extinction commandé électroniquement. Ce dispositif permet un choix précis de la fréquence et du nombre total des éclairs. Un diviseur de tension capacitif assure la synchronisation des impulsions de déclenchement sur l'électrode d'amorçage du tube. Avec un appareillage conçu suivant ce principe les Auteurs ont obtenu à 30 kv de tension anodique des séries de 60 éclairs de rayons X à des fréquences allant jusqu'à 12.000/s. La séparation des images est obtenue à l'aide d'une caméra à tambour tournant avec film extérieur tournant à la vitesse maximale de 80 m/s. A titre d'exemple d'application les Auteurs présentent des séquences montrant le transport du matériel dans la soudure à l'arc et la phase primaire du fonctionnement d'un inflammateur électrique.

Etude sur l'application de l'intensificateur d'image dans la radiographie-éclair

G. Thomer et R. Schall [20]

L'intensité du rayonnement émis par un seul éclair est, à l'heure actuelle, insuffisante pour certaines applications de la radiographie-éclair (p.e. étude des structures cristallines par diffraction) lorsqu'il s'agit d'enregistrements photographiques directs. Une augmentation notable de l'intensité de l'éclair ne peut guère être escomptée; l'émission spécifique de l'anode restera toujours limitée par la puissance que peut supporter l'anode et par ailleurs le temps de pose ne devra évidemment pas excéder les valeurs actuelles (0,2–1.0 μs). Un accroissement de la sensibilité d'enregistrement pourrait donc ouvrir de nouveaux domaines d'application à la technique de la radiographie-éclair. Une possibilité pour une telle amélioration est donnée par les intensificateurs d'image fonctionnant suivant le principe des transformateurs d'image électroniques. Les Auteurs ont étudié expérimentalement les possibilités d'emploi d'un tel appareil pour la radiographie-éclair.

Il s'avère que la définition subit certaines pertes par rapport à l'enregistrement direct mais ceci est également le cas en regime continu. Les défauts de l'image que viennent s'ajouter sous l'influence des charges spatiales en régime discontinu sont négligeables pour des débits jusqu'à 10^4 r/s. La sensibilité par rapport à l'enregistrement direct est 50 fois supérieure à condition d'employer une optique à très grande ouverture et un film très rapide. Le procédé peut présenter des avantages non seulement pour des radiographies isolées mais également pour la radiocinématographie à haute fréquence.

Contourage électronique de la luminosité

R. L. Hallows [23]

Le présent mémoire décrit une technique hétérodoxe de circuit dans laquelle on fait fonctionner un amplificateur à pentode de type normal "sous l'articulation" de la caractéristique de plaque afin d'obtenir l'inversion de la pente caractéristique d'inversion. En projetant des incréments d'amplitude choisis d'un signal-image sur cette caractéristique d'inversion et en supprimant les portions d'image restantes non dans le voisinage immédiat de l'inversion, on obtient un signal ayant une réaction "hors circuit" à l'égard des niveaux des *deux* côtés du niveau incrémental d'entrée et une réaction "en circuit" remarquablement bien définie vis-à-vis du niveau inclus. Le signal de contour ou "profil" ainsi obtenu peut être ajouté au signal d'entrée pour former une présentation combinée dans laquelle on peut faire varier le niveau du contour d'une manière continue aux fins d'observation ou d'analyse.

Un simulateur d'images en télévision

J. P. Smith et J. F. Baumunk [27]

Pour évaluer les systèmes de télévision et pour étudier les techniques de mise en valeur des images, on a besoin d'un équipement simulateur possédant des paramètres réglables et mesurables. Vu que les résultats doivent être reproduits jour après jour et mois après mois, la sûreté des résultats est essentielle dans la construction d'un tel équipement. En outre, quand on évalue des systèmes de haute résolution, les capacités de résolution des moyens d'évaluation doivent être supérieures au système qu'on évalue. Le montage mécanique et électrique doit être suffisamment flexible pour que, lorsque de nouvelles idées se présentent, elles puissent être ajoutées et incorporées à l'équipement existant. Un simulateur d'images de télévision qui satisfait à ces conditions a été réalisé par la Division Astro-Electronique de RCA et est en service depuis plus de deux ans.

Applications récentes des principes de technique acoustique dans les studios et les salles de contrôle

William B. Snow [33]

Le tracé de la surface intérieure d'un studio ou d'une salle de contrôle pour le contrôle acoustique est en partie une question relevant de la science et en partie l'exercice d'un art. On peut obtenir une caractéristique spécifiée de réverbération avec une précision raisonnable, mais la solution d'autres problèmes est surtout une question de jugement. L'auteur passe en revue plusieurs exemples ou l'on s'est efforcé de maintenir un rapport aussi élevé que possible entre la technique et l'empirisme.

Le vieillissement artificiel de l'image latente sur papier Ektacolor

Ted H. Horn [39]

Les variations observées dans les bandes de contrôle du procédé Ektacolor indiquent la nécessité de disposer d'une méthode sure pour la production de bandes impeccables. L'auteur passe en revue les contrôles actuels du procédé afin de déterminer les exigences de cette méthode. Il ressort de cette étude que la principale condition exigée est une période de stabilisation courte,

ce qui implique un vieillissement artificiel. L'agent choisi pour le vieillissement est la chaleur. On effectue des expériences pour déterminer la température et le temps de pose appropriés. D'autres essais sont exécutés pour obtenir des images dans un domaine d'équilibre quasi-normal. L'auteur examine le degré d'exactitude des résultats obtenus.

Algunos aspectos filosóficos de la instrumentación fotográfica de alta velocidad

Morton Sultanoff [1]

Se examinan las fuentes de inexactitud en la interpretación de registros fotográficos obtenidos con la gran variedad de técnicas empleadas en instrumentación fotográfica de alta velocidad. La necesidad de entender los hechos bajo estudio en términos físicos, se manifiesta como un requisito esencial para el análisis y la asociación de la salida luminosa registrada fotográficamente con el hecho estudiado. Se describen las dificultades que se presentan en el análisis de registros de huellas de cámaras de espejo rotativo y se recomienda el empleo simultaneo de equipo complementario para vencer esas dificultades. Se demuestra la necesidad del "acondicionamiento mental" para evitar los errores provenientes de la mala interpretación de los registros fotográficos de alta velocidad. Para evitar las interpretaciones erroneas típicas, como las varias dadas en éste artículo, las características de las cámaras, la luz registrada y las características físicas de los hechos bajo estudio deben analizarse cuidadosamente.

Arco "continuo" en lámparas instantaneas de xenon

Harold E. Edgerton y David Cahlander [7]

Cuando se necesita que una lámpara instantanea funcione a alta velocidad, el circuito de carga tiene que suministrar más corriente. Eventualmente se dá el caso de que la lámpara instantanea no desioniza sino que continúa formando un arco, al que se le llama "continuo" (holdover). Se dan las condiciones para el límite de frecuencia en términos de características de voltioamperios para el circuito y la lámpara. Se presentan datos experimentales sobre varias lámparas instantaneas. Se trata sobre los circuitos que obligan a una lámpara instantanea a funcionar a alta frecuencia, aunque ésta no desionice.

Aplicaciones de radiografía instantanea

J. S. McVeagh [10]

Trata del funcionamiento de los tubos de rayos-x instantaneos de tres electrodos y alto vacío, especialmente en lo relacionado con el uso de éstos tubos en el llamado circuito de bajo voltaje. Se hace notar que éstos tubos pueden emitir impulsos de rayos-x que son muy cortos comparados con el "tiempo de llamada" del circuito eléctrico asociado.

Se introduce una teoria para explicar ésta y otras característi cas del tubo. La teoria pone como postulado la producción de un chorro de plasma que es "bombeado" desde el arco disparador hacia el ánodo mediante el efecto de estímulo (pinch) electromágnetico. El tiempo de exposición de rayos-x corresponde al tiempo de tránsito de este chorro. La teoria también requiere que haya un retardo inicial después de la interrupción del disparador previo a cualquier elevación apreciable de la corriente en el tubo. Se dán ademas algunas pruebas de lo expuesto, junto con algunas verificaciones de perfiles de rayos-x que ilustran las aplicaciones de la técnica instan tanea.

Cinematografía radiológica instantanea de hasta 12.000 imagenes por segundo

A. Stenzel y G. Thomer [18]

Como continuación de los experimentos expuestos en el último congreso de Alta Velocidad (1958) los autores estudian las condiciones que determinan la máxima frecuencia de las descargas periódicas a través de un tubo de rayos-x instantaneo. Con el dispositivo anterior y mediante activación directa del tubo y recarga sencilla R-C o R-L-C, el límite de frecuencia es de cerca de 5.000 por segundo. Para obtener una frecuencia mayor, es necesario aislar el ánodo del condensador de descarga durante las pausas.

En el nuevo circuito, esta separación regulada se obtiene mediante un espinterómetro de chispa amortiguada, activado periódicamente por un generador de impulsos electrónico. El dispositivo permite obtener una regulación estricta de la frecuencia y del numero total de imágenes. Un divisor capacitivo de voltaje asegura la sincronización de los impulsos al electrodo activador del tubo. Con un aparato basado en este principio se produjeron destellos periódicos de rayos-x hasta de 12.000 imágenes por segundo en un total de 60 imágenes. La separación de las imágenes se obtiene mediante una cámara de tambor de 80 m/seg. Como aplicaciones los autores muestran una serie de imágenes de la iniciación de un detonador y de la transición del metal líquido en soldadura de arco.

Aplicación del intensificador de imágen en radiografía instantanea

G. Thomer y R. Schall [20]

Para ciertas aplicaciones de radiografía instantanea, en particular en los estudios de difracción, la intensidad de un solo destello de rayos-x no es suficiente para el registro fotográfico directo. Como no se prevee un posible incremento de la intensidad específica del destello debido a la limitada densidad de la corriente en el ánodo y a la corta duración del destello requerida, se espera que el mejoramiento de la sensibilidad de referencia abra nuevos campos de aplicación a la radiografía instantanea. El intensificador electrónico de la imágen de rayos-x ofrece la posibilidad de llevar a la práctica esta ídea. Los autores estudian las posibilidades de aplicación de éste dispositivo en la técnica instantanea.

Hay que aceptar una ligera perdida de definición, pero esta es casi igual en el caso estacionario. La borrosidad de imágen debida a la presencia de cargas espaciales en la óptica eléctronica por cargas de gran impulso es mínima para dosis unitarias hasta de 10^5 roentgens/seg. Empleando un objetivo de apertura extremadamente amplia y película de alta sensibilidad, la ganancia en sensibilidad es de alrededor de un factor de 50, comparada con la referencia directa usando una película de alta sensibilidad. El método puede ser interesante no solamente para fotografía de un solo destello sino también para cinematografía con destellos de rayos-x.

Acotación electrónica de luminosidad

R. L. Hallows [23]

Se describe una técnica desacostumbrada de circuito, en la que un amplificador de pentodo normal funciona "bajo la rodilla" de la característica anódica para obtener una inversión de la pendiente característica de inversión. Proyectando aumentos de amplitud determinados de una señal de video sobre esta característica de inversión, y suprimiendo las porciones de video restantes que no están en inmediata proximidad de la inversión, dá como resultado una señal con respuesta "negativa" ("off") a los niveles de *ambos* lados del nivel de incremento de entrada y una respuesta positiva ("on") de sorprendente definición al nivel comprendido. La senal de contorno o de "trazo" así obtenida puede sumarse a la señal de entrada para formar un despliegue compuesto en el que el nivel del contorno puede ser variado continuamente para observación o análisis.

Simulador de imagen para televisión

J. P. Smith y J. F. Baumunk [27]

Hay la necesidad de instrumentos simuladores, con parámetros ajustables y medibles, para la apreciación de equipos de televisión y para el estudio de métodos de mejoramiento de imagen. Debido a que hay que reproducir los resultados día tras día y mes tras mes, la exactitud es factor de gran importancia en el diseño del equipo. Del mismo modo en sistemas de simulación de alta definición, el poder de definición de los medios de apreciación debe ser superior al del sistema que se está apreciando. El diseño eléctrico y mecánico debe tener gran adaptabilidad, de manera que cuando se presenten nuevas ideas, puedan desarrollarse y añadirse al equipo existente. La división de Astro Electronica de la RCA ha construído un Simulador de Imagen de televisión que cumple con todos estos requisitos y ha estado empleandose durante más de dos anos.

Aplicaciones recientes de los principios de ingenieria acústica en cuartos de estudios y presentaciones

William B. Snow [33]

El diseno de las superficies interiores de un cuarto de estudio o de presentaciones, en lo relacionado con el control acústico, es en parte un trabajo científico y en parte una ejecución artística. Una característica de reverberación determinada puede obtenerse con considerable precisión, pero hay otros problemas que se resuelven principalmente a base de criterio. Se consideran varios ejemplos en los que se trató de mantener la relación entre ingenieria y regla empírica lo más alta posible.

Envejecimiento artificial de la imagen latente en papel Ektacolor

Ted H. Horn [39]

Las variaciones de las tiras de papel Ektacolor en la regulación del proceso, indican que se necesita un método para producir tiras de papel que den mayor seguridad y precisión. Para determinar los requisitos de un método satisfactorio se han examinado los actuales reguladores del proceso. Se ha encontrado que el requisito principal es el de un período de establiización corto. Esto implica envejecimiento forzado. Como agente de envejecimiento se ha elegido el calor. Se han realizado experimentos para hallar la temperatura y el tiempo de exposición adecuados. Se adelantan, además, otros experimentos para obtener imágenes en una gama compensada casi normal. Trata también sobre la utilidad de los resultados.

Einige philosophische Betrachtungen über die Apparate der Hochgeschwindigkeits-Photographie

Morton Sultanoff [1]

Es werden die Quellen der Ungewissheit geprüft, die sich bei der Interpretation photographischer Aufnahmen ergeben, die nach vielen der mit photographischen Hochgeschwindigkeits-Instrumenten angewandten Methoden erzielt werden. Es wird gezeigt, dass es absolut notwendig ist die zu studierenden Ereignisse physikalisch zu verstehen, wenn man ihre photographisch aufgenommenen Lichtspuren analysieren und in die rechte Beziehung bringen will.

Es werden die Schwierigkeiten beschrieben, die sich bei der Analyse von Schlierenaufnahmen ergeben, die mit Rotorspiegel-Kameras gemacht wurden und es wird der gleichzeitige Gebrauch verwandter Geräte empfohlen, um diese Schwierigkeiten zu vermeiden. Es wird die Notwendigkeit für eine "geistige Vorbereitung" bewiesen, um die Fallen falsch ausgelegter photographischer Hochgeschwindigkeitsaufnahmen zu vermeiden. Man muss die Natur der Kameras, des aufgenommenen Lichts und die

physikalischen Eigenschaften der untersuchten Ereignisse sorgfältig analysieren um typische Falschauslegungen zu vermeiden, von denen einige in diesem Artikel illustriert werden.

Nachleuchten in Xenon-Blitzlampen

Harold E. Edgerton and David Cahlander [7]

Wenn eine Blitzlampe in rascher Aufeinanderfolge zu leuchten hat, so muss der aufladende Stromkreis eine grössere Menge Strom liefern. Dies führt schliesslich zu einem Zustand, in welchem die Blitzlampe nicht entionisiert wird sondern in einen dauernden Lichtbogen übergeht den man "holdover" (Uberbleibsel) nennt. Der Artikel gibt die Daten der maximalen Frequenzen in der Form von Volt-Ampere-Charakteristiken für Stromkreis und Lampe. Auch werden experimentelle Daten für verschiedene Blitzlampen gebracht. Weiterhin folgt eine Erörterung der Stromkreise, welche eine Blitzlampe dazu zwingen mit hoher Frequenz zu arbeiten, selbst dann wenn sie nicht entionisiert ist.

Anwendungen der Blitz-Röntgenphotographie

J. S. McVeagh [10]

Es wird die Funktion der 3-Elektroden- Hart-Vakuum- Blitz- Röntgenröhren besprochen und zwar mit besonderem Bezug auf die Verwendung dieser Röhren im sogenannten Niederspannungs-Stromkreis. Es wird hervorgehoben, dass diese Röhren imstande sind, Impulse von Röntgenstrahlen auszusenden welche, verglichen mit der "Läutezeit" des dazugehörigen Stromkreises, sehr kurz sind.

Es wird eine Theorie aufgestellt, um diese sowie andere Eigenschaften der Röhre zu erklären. Diese Theorie besagt, dass ein Plasmastrahl entsteht, der vom auslösenden Lichtbogen durch den elektromagnetischen Quetscheffekt zur Anode "gepumpt" wird. Die Röntgenstrahlen-Belichtungszeit entspricht der Ubergangszeit dieses Strahls. Die Theorie verlangt auch, dass nach dem Abbrechen des Auslösers eine anfängliche Verzögerung besteht, bevor ein merkliches Ansteigen des Stroms in der Röhre stattfindet. Es wird eine gewisse Beweisführung hierfür erbracht, und es werden einige Röntgenbilder gezeigt, die verschiedene Anwendungen der Blitzmethode illustrieren.

Kinematographie mit Röntgenblitzen bei Frequenzen bis zu 12.000 Bildern/s

A. Stenzel und G. Thomer [18]

In Fortführung der auf dem letzten Kongress (Köln 1958) vorgetragenen Versuche wurden die Bedingungen untersucht, die für eine Erhöhung der Frequenz periodischer Entladungen durch ein Röntgenblitzrohr von Bedeutung sind. Bei der früher verwendeten Schaltung, bei welcher der Wiederanstieg der Anodenspannung durch einen R-C-bzw. R-L-C-Kreis bestimmt wird und die Steuerung der Blitze allein durch Impulse auf die Zündelektrode des Röntgenrohres erfolgt, liegt die erreichbare Grenzfrequenz bei etwa 5.000/s. Um zu höheren Frequenzen zu gelangen, ist es notwendig, dass die Anodenspannung während der Pausen völlig abgeschaltet bleibt.

Bei der neuen Apparatur wird die periodische Trennung von Entladekapazität und Blitzrohr durch eine elektronisch gesteuerte Löschfunkenstrecke erreicht. Die Anordnung erlaubt eine präzise Einstellung der Frequenz und der Serienlänge. Ein kapazitiver Spannungsteiler sorgt für die nötigen synchronisierten Zündimpulse auf die Triggerelektrode des Röntgenrohres. Mit einer nach diesem Prinzip aufgebauten Apparatur wurden bei 30 kV Anodenspannung periodische Röntgenblitze mit Frequenzen bis zu 12.000/s, bei einer Serienlänge von 60 Blitzen erzeugt. Die Bildtrennung erfolgt mit Hilfe einer Trommelkamera mit Aussenfilm bei 80 m/s maximaler Filmgeschwindigkeit. Als Anwendungsbeispiele werden Ausschnitte aus Bildstreifen gezeigt, welche den Materialübergang bei der Lichtbogenschweissung sowie die Primavorgänge beim Ansprechen einer elektrischen Zündpille sichtbar machen.

Versuche zur Anwendung des Bildverstärkers in der Röntgenblitzphotographie

G. Thomer und R. Schall [20]

Für gewisse Anwendungen der Röntgenblitzphotographie (z.B. bei Feinstrukturuntersuchungen) reicht derzeit die Intensität der bei einem Blitz emittierten Strahlung für eine direkte photographische Registrierung mit Film und Verstärkungsfolien nicht aus. Eine weitere wesentliche Steigerung der Blitzintensität ist kaum zu erwarten; die Leuchtdichte der Anode bleibt aus Gründen der theoretischen Belastbarkeit begrenzt und die Belichtungszeit (0,2–1,0 μs) soll selbstverständlich nicht erhöht werden. Eine Erhöhung der Empfindlichkeit der Registrierung dürfte daher der Röntgenblitztechnik neue fruchtbare Anwendungsgebiete erschliessen. Eine Möglichkeit zu einer solchen Verbesserung bieten die nach dem Prinzip der elektronischen Bildwandler arbeitenden Röntgenbildverstärker. In der vorliegenden Arbeit wird experimentell die Anwendbarkeit eines solchen Gerätes in der Blitztechnik geprüft.

Es zeigt sich, dass man zwar einen gewissen Verlust an Auflösungsvermögen gegenüber der direkten Registrierung in Kauf nehmen muss, aber dies gilt schon für den stationaren Fall. Die zusätzlich durch Raumladungen im Elektronenbild bei Impulsbelastung auftretenden Bildfehler sind bis zu Dosisleistungen von 10^6 r/s vernachlässigbar. Als Gewinn an Empfindlichkeit ergibt sich bei Verwendung lichtstärkster Optik und hochempfindlichen Films etwa ein Faktor 50 gegenüber der direkten Registrierung. Das Verfahren kann ausser für Einzelaufnahmen auch für Hochfrequenzkinematographie mit Röntgenblitzen von Vorteil sein.

Elektronische Helligkeitsumzeichnung

R. L. Hallows [23]

Es wird ein ungewöhnlicher Stromkreis beschrieben, in dem ein Pentodenverstärker üblicher Ausführung "unterhalb des Knicks" der Anodenspannungs-Kennlinie arbeitet um eine Umkehrung der Steilheit der Umkehrungscharakteristik zu erzielen. Das Senden ausgewählter Amplitudeninkremente eines Fernsehsignals über diese Umkehrcharakteristik und das Ausmerzen der verbleibenden Fernsehteile die nicht in der unmittelbaren Nähe der Umkehrung liegen, ergibt ein Signal mit einer "Aus"- Empfindlichkeit gegenüber Niveaus auf *beiden* Seiten des Eingangs-Inkrementpegels und eine überraschend gute "An"-Empfindlichkeit gegenüber der eingeschlossenen Höhe. Das Kontur- oder "Umrissignal," welches auf diese Weise erhalten wurde, kann zu dem Eingangssignal hinzugefügt werden um eine zusammengezetzte Vorführung zu erzielen, bei welcher die Kennlinie der Kontur für Zwecke der Beobachtung oder der Analyse kontinuierlich geändert werden kann.

Ein Fernseh-Bildsimulator

J. P. Smith und J. F. Baumunk [27]

Zur Beurteilung von Fernsehanlagen und zur Untersuchung der Verfahren für bessere Bilddarstellung werden Simulierapparate benötigt, die ein Einstellen und Messen der Parameter erlauben. Da es notwendig ist die Prüfergebnisse von Tag zu Tag und von Monat zu Monat genau zu wiederholen, ist beim Entwurf der Geräte auf grösste Verlässlichkeit zu achten. Wenn es sich um das Prüfen von Anlagen mit hoher Resolution handelt, müssen die Resolutionseigenschaften der Prüfmittel besser sein als die der zu prüfenden Anlage. Sowohl der mechanische wie auch der elektrische Teil des Entwurfes müssen eine gewisse Vielseitigkeit und Anpassungsfähigkeit aufweisen, damit beim Auftauchen neuer Ideen solche Grundsätze ausgebaut und dem bestehenden Gerät angegliedert werden können. Die Astro-Electronics Division von RCA hat einen Fernseh-Bildsimulator gebaut der diesen Anforderungen entspricht und seit über zwei Jahren im Betrieb ist.

Neuere Anwendungen von technischen Grundsätzen der Akustik in Sende- und Probevorführungsräumen

William B. Snow [33]

Das Entwerfen der Innenflächen eines Sende- oder Probevorführungsraumes hinsichtlich der akustischen Regelung ist teils eine wissenschaftliche und teils eine künstlerische Arbeit. Obwohl sich eine bestimmte Nachhalleigenschaft mit einiger Genauigkeit erzielen lässt, müssen doch andere Probleme hauptsächlich durch gesunde Urteilskraft gelöst werden. Es werden verschiedene Beispiele erörtert werden, bei denen versucht wurde einen möglichst hohen Prozentsatz technischer Grundsätze gegenüber schätzungsweisen Erwägungen anzuwenden.

Das künstliche Altern des latenten Bildes im Ektacolor-Papier

Ted H. Horn [39]

Variationen in den im Ektacolor-Prozess verwendeten Prüfstreifen zeigen, dass es notwendig ist eine Methode zur Herstellung verlässlicher Streifen zu finden. Die gegenwärtigen Prüfmassnahmen des Arbeitsvorganges werden untersucht um die Erfordernisse einer solchen Methode festzulegen. Man hat gefunden dass eine kurze Stabilisierungszeit das Haupterfordernis ist und dies bedeutet beschleunigtes Altern. Als Alterungsmittel wird Hitze gewählt. Es werden Versuche angestellt um die geeignete Temperatur und Belichtungszeit zu finden. Weitere Versuche zielen dahin Bilder von fast normalem Ausgleich zu erhalten. Es wird die Verlässlichkeit der Ergebnisse erörtert.

Ed. Note: Beginning with this issue, we hope to include in the *Journal* as a regular feature translations of the titles and abstracts of all papers in French, German and Spanish. This is intended to increase the *Journal's* usefulness to the Society's growing number of non-English speaking members and subscribers overseas. Comments of readers are invited. The Society is particularly anxious that the translations used should be of the best quality obtainable, therefore comments on their quality and suggestions for their improvement would be especially welcome. Also, since the cost of buying all the translations from a commercial translator is prohibitive, any assistance that may be volunteered in obtaining translations for the *Journal* will constitute a very considerable contribution to the Society. Contributors will of course, be given full acknowledgment in the *Journal.*

Contents — pages 45-80

News Columns

Advertisers

Meeting Calendar

International Solid-State Circuits Conference, Feb. 15–17, Univ. of Pennsylvania and Sheraton Hotel, Philadelphia.
Optical Society of America, Spring Meeting, Mar. 2–4, Pick-Roosevelt Hotel, Pittsburgh, Pa.
ASME, National Aviation Division Conference, Mar. 12–16, Statler Hotel, Los Angeles.
American Society of Photogrammetry, ASP-American Congress on Surveying and Mapping, Mar. 19–25, Shoreham Hotel, Washington, D.C.
IRE International Convention, Mar. 20–23, New York Coliseum, New York.
National Microfilm Association, National Convention, Apr. 4–6, Hotel Sherman, Chicago.
ASTM, Committee F-1 on Materials for Electron Tubes and Semiconductor Devices, Apr. 5–7, Benjamin Franklin Hotel, Philadelphia.
Inter-Society Color Council, 30th Annual Meeting, Apr. 10–12, Sheraton Hotel, Rochester, N.Y.
ISA, 7th National Symposium on Instrument Methods of Analysis, Apr. 17–19, Shamrock-Hilton Hotel, Houston, Texas.
DAVI, Apr. 24–28, Deauville Hotel, Miami Beach, Fla.
ISA, 7th National Aero-Space Instrumentation Symposium, May 1–4, Fort Worth, Tex.
89th Semiannual Convention of the SMPTE, May 7–12, King Edward Sheraton, Toronto.
SPSE, Annual Conference, May 8–12, Arlington Hotel, Binghamton, N.Y.
IRE Professional Group on Microwave Theory and Techniques, National Symposium May 15–17, Sheraton-Park Hotel, Washington, D.C.
AIEE, ARS, IAS, IRE, ISA, National Telemetering Conference, May 22–24, Sheraton Towers Hotel, Chicago.
ASME, Semiannual Meeting, June 11, Los Angeles.
AIEE, Summer General Meeting, June 18–23, Ithaca, N.Y.
AIChE, AIEE, ASME, IRE, ISA, Joint Automatic Control Conference, June 28–30, Univ. of Colorado, Boulder, Colo.
IFME, JECMB, IRE-PGBME, 4th International Conference on Medical Electronics and 14th Conference on Electronic Techniques in Medicine and Biology, July 16–22, Waldorf-Astoria Hotel, New York.
NAVA, Annual Convention, July 22–25, Hotel Morrison, Chicago.
SPIE, National Convention, Aug. 7–10, Ambassador Hotel, Los Angeles.
Western Electronic Show and Convention, Aug. 22–25, San Francisco.
American Chemical Society, 6th International Conference on Coordination Chemistry, Aug. 27–Sept. 1, Wayne State Univ., Detroit, Mich.
UFPA, Annual Meeting, August 1961, Berkeley Campus, U. of California.
PGIT, International Symposium on Transmission and Processing of Information, Sept. 6–8, MIT, Cambridge, Mass.
90th Semiannual Convention of the SMPTE, Oct. 2–6, Lake Placid, N.Y.
National Electronics Conference, Oct. 9–11, International Amphitheatre, Chicago.
Society of Reproduction Engineers, Visual Communications Congress, Dec. 1–4, Hotel Biltmore, Los Angeles.
91st Semiannual Convention of the SMPTE, Apr. 30–May 4, 1962, Ambassador Hotel, Los Angeles.
92nd Semiannual Convention of the SMPTE, Oct. 22–26, 1962, Drake Hotel, Chicago.
93rd Semiannual Convention of the SMPTE, Apr. 22–26, 1963, Traymore Hotel, Atlantic City, N.J.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1960 Journal Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

The objectives of the Society are:

- Advance in the theory and practice of engineering in motion pictures, television and the allied arts and sciences;
- Standardization of equipment and practices employed therein;
- Maintenance of high professional standing among its members;
- Guidance of students and the attainment of high standards of education;
- Dissemination of scientific knowledge by publication.

Progress toward the attainment of these objectives is greatly aided by the financial support provided by the member companies listed below.

- Acme Film Laboratories, Inc.
- Alexander Film Co.
- Altec Service Company
  - Altec Lansing Corporation
- American Broadcasting-Paramount Theatres, Inc.
  - ABC-TV Network
  - ABC Films, Inc.
- Ampex Professional Products Company
- Animation Equipment Corp.
- Ansco
- Arriflex Corp. of America
- The Association of Cinema Laboratories, Inc.
- Association of Professional Cinema Equipment Dealers of New York
  - Camera Equipment Company, Inc.
  - The Camera Mart, Inc.
  - Florman & Babb, Inc.
  - National Cine Equipment, Inc.
  - S.O.S Cinema Supply Corporation
- Atlas Film Corporation
- Audio Productions, Inc.
- Bach Auricon, Inc.
- Bausch & Lomb Optical Co.
- Beckman & Whitley, Inc.
- Bell & Howell Company
- Bonded Film Storage (Division of Novo Industrial Corp.)
- Brooks Cameras & Supply
- Byron Motion Pictures, Inc.
- S. W. Caldwell Ltd.
- Calvin Productions, Inc.
- Capital Film Laboratories, Inc.
- Oscar F. Carlson Company
- Century Lighting, Inc.
- Century Projector Corporation
- Cineffects, Inc.
- Cinesound, Ltd., Canada
- Geo. W. Colburn Laboratory, Inc.
- Color Reproduction Company
- Color Service Company, Inc.
- Columbia Broadcasting System, Inc.
  - CBS Television Network; CBS Television Stations; CBS News; CBS Films; Terrytoons
- Commonwealth-Filmcraft Laboratories Pty. Ltd.
- Comprehensive Service Corporation
- Consolidated Film Industries
- Dage Television Division of Thompson Ramo Wooldridge Inc.
- DeFrenes Company
- DeLuxe Laboratories, Inc.
- Desilu Productions, Inc.
- Du Art Film Laboratories, Inc.
  - Tri Art Color Corporation
- E. I. du Pont de Nemours & Co., Inc.
- Eastern Effects, Inc.
- Eastman Kodak Company
- Edgerton, Germeshausen & Grier, Inc.
- Elgeet Optical Company, Inc.
- Max Factor & Co.
- Field Emission Corporation
- Filmline Corporation
- Dr.-Ing. Frank Früngel GmbH
- GPL Division of General Precision, Inc.
- General Electric Company
- General Film Laboratories Corporation
- W. J. German, Inc.
- The Gevaert Company of America, Inc.
- Guffanti Film Laboratories, Inc.
- Frank Herrnfeld Engineering Corp.
- Hi-Speed Equipment Incorporated
- Hollywood Film Company
- Hollywood Film Enterprises, Inc.
- Houston Fearless Company
- Philip A. Hunt Company
- Hunt's Theatres
- Hurletron Incorporated
- Hurley Screen Company
- JM Developments, Inc.
- The Jam Handy Organization, Inc.
- Jamieson Film Co.
- The Kalart Company Inc.
  - Victor Animatograph Corporation
- Kear & Kennedy Engineering
- Keitz & Herndon, Incorporated
- KIN-O-LUX, Inc.
- Kollmorgen Optical Corporation
- Labcraft International Corporation
- LAB-TV
- Robert Lawrence Productions, Inc.
- Lipsner-Smith Corporation
- Lorraine Arc Carbons, Division of Carbons, Inc.
- M.G.M. Laboratories, Inc.
- Mecca Film Laboratories Corporation
- D. B. Milliken Company
- Minnesota Mining & Manufacturing Co.
- Mitchell Camera Corporation
- Mole-Richardson Co.
- Monaco Laboratories
- Motion Picture Association of America, Inc.
  - Allied Artists Pictures Corporation
  - Buena Vista Film Distribution Company, Inc.
  - Columbia Pictures Corporation
  - Loew's Incorporated
  - Paramount Pictures Corporation
  - Twentieth Century-Fox Film Corp.
  - United Artists Corporation
  - Universal Pictures Company, Inc.
  - Warner Bros. Pictures, Inc.
- Motion Picture Enterprises, Inc.
- Motion Picture Laboratories, Inc.
- Motion Picture Printing Equipment Co.
- Movielab Film Laboratories, Inc.
- Moviola Manufacturing Co.
- National Carbon Company, Division of Union Carbide Corporation
- National Screen Service Corporation
- National Theatre Supply Company
- Neumade Products Corporation
- W. A. Palmer Films, Inc.
- Pan-American Films
- Panavision Incorporated
- Pathé Laboratories, Inc.
- Photo-Animation, Inc.
- Photo-Sonics, Inc.
- Pittsburgh Motion Picture Lab
- Precision Laboratories (Division of Precision Cine Equipment Corporation)
- Prestoseal Mfg. Corp.
- Producers Service Company, Division of Boothe Leasing Corp.
- Radio Corporation of America
  - National Broadcasting Company
  - Broadcast and Television Equipment Division
- Rank Precision Industries Ltd.
  - G. B-Kalee Division
- Rapid Film Technique, Inc.
- Reid H. Ray Film Industries, Inc.
- Reeves Sound Studios, Inc.
- RIVA-Munich
- Charles Ross Inc.
- Russell-Barton Film Company
- L. B. Russell Chemicals, Inc.
- Ryder Sound Services, Inc.
- Bruce J. Scrievers, Consulting Engineer
- Scripts By Oeveste Granducci, Inc.
- Smith, Kline & French Laboratories
- Snazelle Productions, Inc.
- Southwest Film Laboratory, Inc.
- The Strong Electric Company
- Sylvania Electric Products, Inc.
- Technicolor Corporation
- TELIC, Incorporated
- Titra Film Laboratories, Inc.
- Traid Corporation
- Trans-Canada Films Ltd.
- Van Praag Productions
- Alexander F. Victor Enterprises, Inc.
- Westinghouse Electric Corporation
- Westrex Corporation
- Wilding Inc.
- Wollensak Optical Company

The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Ethan M. Stifle, Eastman Kodak Co., Room 626, 342 Madison Ave., New York 17, N.Y.